POWER PLANT ENGINEERING

Established Over 30 Years

VOL. XXX CHICAGO, DECEMBER 1, 1926 No. 23

Contents of this Issue

Page

Engines Supply Power for Making Bath-tubs. Illustrated.1248
Studies of the Pumping of Viscous Liquids. By M. P. O'Brien and M. W. Todd. Illustrated.....1253
Fuel Sizing for Chain Grate Stokers. By F. C. Duennes. Illustrated 1257
Over-Speed Device Should Not Be Neglected. By J. J. McDougall 1257
Gas Producer and Steam Boiler Combined. By Chas. J. Webb. Illustrated 1258
M A N Engine Tested Under Severe Conditions. Illustrated 1259
Gasoline Engines as Standby or Emergency Power. By G. S. Hamilton. Illustrated 1261
Chlorine Keeps Tubes Clean.....1261
Transformer Oil Handling in Power Plants. By Erik G. Sohlberg 1262
Need for Quality Production of Value to Small Central Station. By L. W. Alwyn-Schmidt.....1266
Electric Power Makes Progress.....1267
Bartlett's Ferry Begins Operation with Two Units. Illustrated 1268
What Is Super Power? By Henry W. Ballou.....1270
Use of Clips on Wire Rope. Illustrated.....1271
Secretary Hoover Urges Reduction of Wastes.....1272
Refrigeration for New Madison Square Garden. By Austin C. Lescarboura. Illustrated 1273
De-Concentration of Feed Water Effects Marked Savings.1275
Liability for Infringement of Patents. By Leo T. Parker.1276
Unit Pulverizers for Paper Mills. Illustrated.....1278
Letters Direct from the Plant: Losses Due to Light Loading of Steam Engines. Truck Specially Built for Hauling Boulders. Motor-Operated Valves. Length of Crossed Belts. Simple Methods Improve Boiler Performance. Automatic Regulation Pays. Illustrated 1279
Questions and Answers: Transformer Connections. Steam Problems from Massachusetts Examination Questions. Calculating the Proper Size of a Safety Valve. Illustrated 1282
Editorial Comment: Conserving Our Fuel Supply. Sound Business Ahead. The Right Kind of Public Ownership 1284
Power Plant Development Number.....1285
Opportunity Awaits Engineers. Illustrated.....1286
Consumers' Coal Stocks Increase Despite Exports. Illustrated 1301
Worthington Receives Repeat Order for Shipping Board Diesels. Illustrated 1302
Fisher Remote Control of Liquid Levels. Illustrated....1302
Detroit Edison to Build Delray No. 3.....1303
Electric Gas Analysis Equipment. Illustrated.....:1303
Air Filter Cleaning Device Now Available. Illustrated....1304
Work Started on Diablo Project.....1304
Death of James B. Stanwood.....1305
News Notes 1305
Catalog Notes 1306

Published on the 1st and 15th of each Month by the
Technical Publishing Co., 53 West Jackson Blvd., Chicago
New York Office, 150 Nassau Street

Subscription price $2.00 a year in the United States and possessions. Canada $2.75 a year. Other countries $3.50 a year. Single copies 15 cents.

Copyright 1926, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Member, Associated Business Papers, Audit Bureau of Circulations

Circulation of this Issue 23,500.

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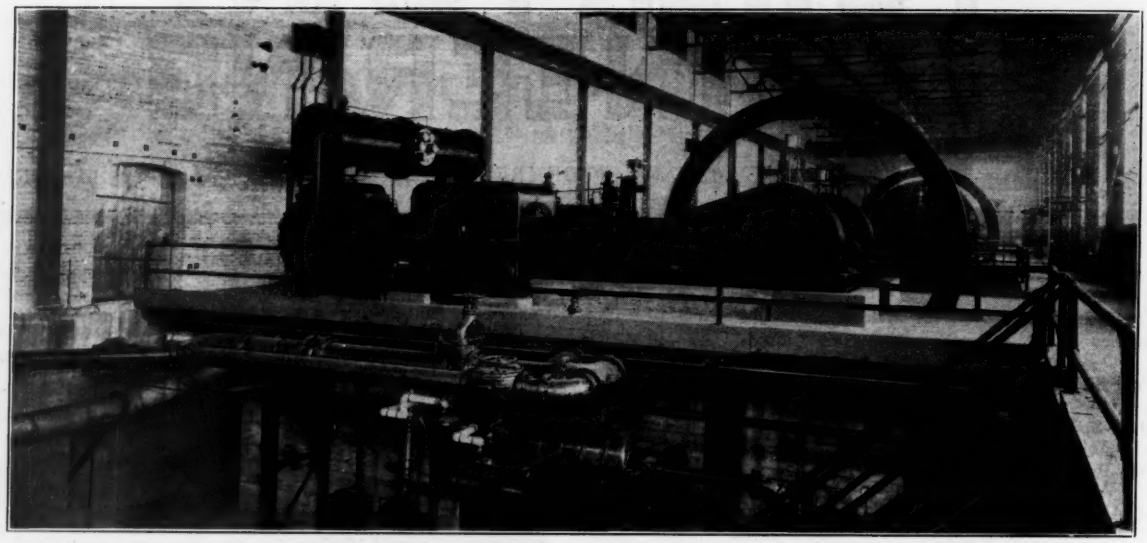
At the Sign of the Cat's Whiskers

ANCIENT MARINERS sailing the briny deep were woefully handicapped in their facility of expression. They had no breezy vocabulary as we have today and such expressions of delight and rapture as "Oh Boy" and "Hot Dog" were unknown to them. "The Cat's Whiskers" signified nothing more than the whiskers of a pussy cat. Yet, how they could have used it! When, on a homeward voyage after a four-year tussle on the whaling grounds, the blue glow of St. Elmo's fire made its appearance at the mastheads of their ship, what would have expressed their delight better than that it was the "Cat's Whiskers." For St. Elmo's fire was always considered a good omen—a visible sign of the guardianship of their patron saint, St. Elmo.

Of course, this was a lot of nonsense. St. Elmo, no doubt, was a beneficient old bird, but he never won the Nobel prize as an illuminating engineer, in fact, he never had a hand in the blue light business. Foot candles and Lumens were strangers to him. St. Elmo's fire is nothing more than the glow accompanying the discharge of electricity from earth to the atmosphere. It is a phenomenon identical with that shown in the picture above, which happens to be a photograph of the million-volt brush or corona discharge over an insulator in the General Electric Co. laboratory. As a remarkable example of man-made St. Elmo's fire, we think it's "the Cat's Whiskers."



Engines Supply Power for Making Bath-tubs

POWER FACILITIES OF KOHLER CO.'S GREAT FACTORY AT KOHLER, WISC., INCREASED BY ADDITIONAL ENGINE-DRIVEN UNITS AND NEW BOILERS EQUIPPED WITH AIR PREHEATERS

MANY PEOPLE NOTICE the name Kohler stamped neatly and unobtrusively on bath-tubs, lavatories and other bathroom appurtenances but not all are aware that this equipment is the product of a most unusual and interesting industrial organization, the Kohler Co. Owing to recent expansions of the company's manufacturing plant at Kohler, Wisc., about 4 mi. from Sheboygan, an addition to its power plant was necessary and it is the purpose of this article to describe the principal features of this power plant.

We have not space in this article to discuss in detail the unusual development of Kohler Village. This is a community built according to a definite plan by the workers of the Kohler Co., developed into a place in which they take pride in living and operated by them in a way that is singularly free from those characteristics that so often handicap the development and usefulness of communities built around a particular industry.

Enameled plumbing ware is, of course, the chief product of the Kohler Co. Within the past two years it has begun, in addition, to manufacture a small self-contained automatic electric generator unit, driven by either gasoline or gas, in sizes up to 2000 w. at 110 v. In the plumbing ware processes, foundry work plays an important part and large quantities of electric power, steam and compressed air are used in handling materials in mechanical and chemical operations and the like. The making of automatic electric plants involves production of internal combustion engines and electric generators, these processes also needing power, steam and compressed air. In winter, the heating load on the buildings alone amounts to about 30,000 lb. of steam an hour.

FIG. 1. TYPICAL STREET IN KOHLER, WISC.

ANALYSIS OF CONDITIONS INDICATED USE OF MORE ENGINES

Before extending the former power plant, in which engine-driven d.c. generators and engine-driven air compressors were installed, careful analysis was made of the situation. At that time, in the north end of the manufacturing plant, a small a. c. load of 200 kw. was supplied by power purchased from a public utility company. The greater part of the plant, however, was wired for d. c., all motors in the plant being d. c. 230-v. units. It was decided finally that the expense of replacing the d. c. factory equipment made it preferable to install more engine-driven d. c. generators instead of turbine-driven a. c. units. The maximum transmission distance in the plant will not be much over 2000 ft. and this distance does not offer unusual difficulties for d. c. transmission.

The power plant building is 105 ft. wide, the engine room occupying 55 ft. of this width and the boiler room the remainder. With the addition, as shown in Fig. 2, the building is now 300 ft. long. The original design, of steel and brick with Truscon steel window sash, has been carried out in the addition and produces a well-lighted, well-ventilated and attractive plant. The roof

is of hollow tile, as shown, supported on trusses, their bottom chords being 35 ft. from the floor. Below the trusses runs a 25-t. Manning, Maxwell & Moore traveling crane.

Original Engine Installation

In the original engine room, as shown at the right in Fig. 2, were installed a number of engine-driven generators and air compressors. All electric power is generated at 230 v. Number 1 generating unit consists of a 750-kw. Crocker-Wheeler generator driven at 100 r.p.m. by a 24 by 48 by 42-in. Wisconsin Engine Co. cross-compound Corliss engine. Number 2 unit is an 18 by 36-in. Wisconsin Engine Co. simple Corliss, driving a 250-kw. Crocker-Wheeler generator at 125 r.p.m. Number 3 is a 28 by 36-in. Nordberg Uniflow driving a 500-kw. Crocker-Wheeler generator at 150 r.p.m. The uniflow engine is shown in Fig. 7. The 750-kw. unit is equipped with a barometric condenser for use when the exhaust is not needed in the factory. The other two units are operated to furnish exhaust for feed water and domestic water heating during the summer, the 500-kw. unit being used mostly for this purpose. Richardson-Phenix force feed lubricating systems are installed on all the above-mentioned units. Lubricating oil is purified by White Star filters on the Corliss engines, while a Nordberg oil filter was supplied with the uniflow.

In the original plant were also installed several air compressors for supplying air used in various manufacturing processes. To supply air at 40-lb. pressure for sand blast work, a Worthington Feather Valve (Laidlaw) steam-driven compressor is installed. This is of the flywheel type and has a rated capacity of 6000 c.f.m. at speed of 110 r.p.m., with cylinder dimensions of 18/36 by 29/17 by 36 in. A second Worthington 3500 c.f.m. flywheel type compressor with cylinders 16/32 by 29/17 by 36 in., operating at 110 r.p.m., supplies air at 100 lb. pressure to the factory. Steam cylinders of these units are cross-compound, with Corliss valves. They are arranged to exhaust when necessary into Prescott barometric condensers installed on the outside wall of the engine room. Besides these two large compressors, there are two 1000 c.f.m. Ingersoll-Rand compressors, belt-driven from 170-hp. Crocker-Wheeler, 230-v. d. c. motors to supply air for domestic work.

FIG. 3. TWO 520-HP. BOILERS ARE SET IN NEW BOILER ROOM, WITH SPACE FOR FUTURE UNITS

Condenser circulating water for the above condensers is pumped by Worthington, 1000-g.p.m. centrifugal pumps driven at 1700 r.p.m. by 15-hp. Crocker-Wheeler motors. This water is taken from the main water storage system which will be described later.

Addition was Designed for Four New Units

In designing the addition to the plant, space was allowed, as shown in Fig. 2, for the installation of two new generating units and two new compressors. For the present, however, only one of each is installed. The new generating unit, shown in Fig. 5 and in the headpiece, is an Allis-Chalmers machine, rated at 1650 kw., 230 v., 100 r.p.m. with cylinders 32 by 54 by 83 in. This takes steam at 225 lb. gage at the throttle. The high-pressure cylinder has piston steam valves and piston exhaust valves, while all four valves of the low-pressure cylinder are of the Corliss type. Figure 6 shows the new air compressor, also an Allis-Chalmers machine, rated at 5000 cu. ft. of free air a minute at 100-lb. pressure and at 100 r.p.m. The steam cylinder

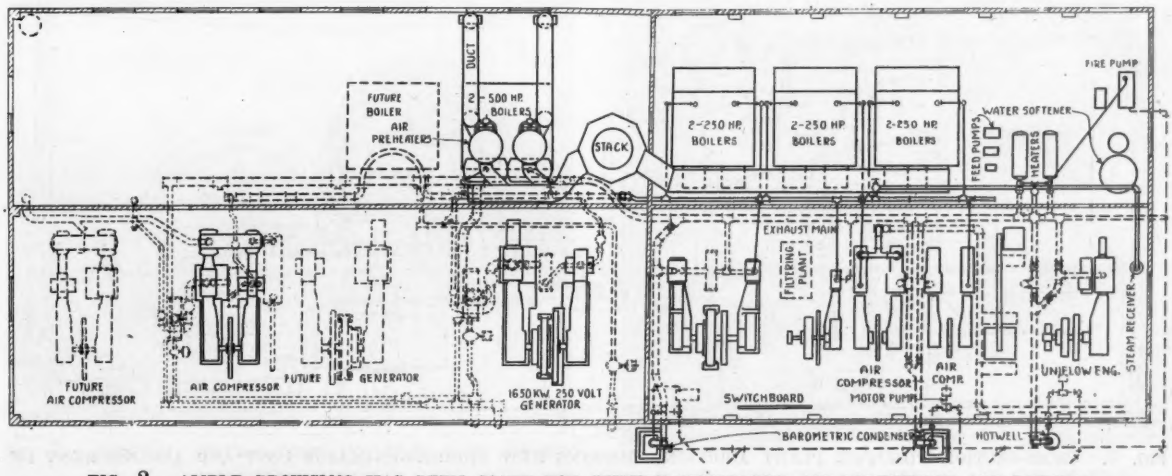


FIG. 2. AMPLE PROVISION HAS BEEN MADE FOR FUTURE GENERATOR, AIR COMPRESSOR AND BOILERS

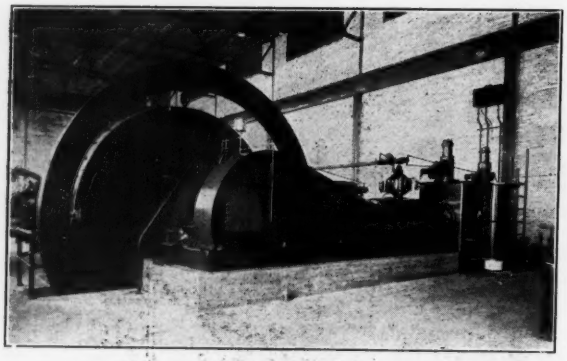


FIG. 5. HIGH PRESSURE CYLINDER OF NEW 1650-KW., CROSS-COMPOUND GENERATOR UNIT

dimensions of this unit are 18 by 40 by 42 in. and the air compressor cylinder is the same size. These units are also equipped with Bowser (Richardson-Phenix) lubricators and oil filters.

Both of the new units may be run condensing when necessary, as they have been equipped with Worthington surface condensers of 2300 sq. ft. each. These are installed in the basement below their respective engines, together with Worthington motor-driven circulating and condensate pumps.

It will be noted, on referring to Fig. 2, that, although each of the engines with the exception of the simple engine has a condenser available for use, a bypass is provided around it by which the exhaust is led to a common exhaust header running the length of the power house and thence into the factory buildings. By closing the proper valves, this arrangement allows various units to be run condensing or noncondensing, depending on the exhaust steam demand, thus providing a flexible operating layout and giving control of heat balance. Pressure in the exhaust header is maintained at about 5 lb. gage for heating, live steam being supplied to this header through reducing valves when engines are not operating.

Two Groups of Boilers Generate Steam

The two new engines take steam at 225-lb. gage at the throttle, while the original engines use steam at 150 lb. This steam is generated in two groups of boilers: The original installation, Fig. 9, and the new boilers, Fig. 3, that have been added to meet the increased demands. The original boilers consisted of six Babcock & Wilcox water tube boilers, each having 2500 sq. ft. of heating surface, set in three batteries of two boilers each. These boilers generate steam at 160-lb. gage. They are fired by motor-driven Murphy stokers, as shown in Fig. 9. Feed water level is controlled by S-C feed water level regulators, soot is removed by Diamond soot blowers and boilers are blown down through Homestead blowoff valves. Crosby pressure gages are installed, together with Bailey flow meters at suitable points. Crane nonreturn valves give control of the main steam header. These boilers are shown in Figs. 2 and 9. The Murphy stokers operate with natural draft, which is furnished by a Custodis chimney 175 ft. high and 10 ft. in inside diameter.

Two Wickes boilers have been installed in battery in the new section of the boiler house. Figure 10 shows these boilers in process of erection and Fig. 3 as they appear at present. They are of the cross-drum, water-tube type, with a heating surface of 5190 sq. ft. each, generating steam at 225-lb. gage. The boilers and settings are designed so that at some future time superheaters may be installed to give 100 deg. of superheat. The new boilers are fired by Frederick underfeed stokers furnished by Combustion Engineering Corp., which are supplied with preheated air. They are equipped

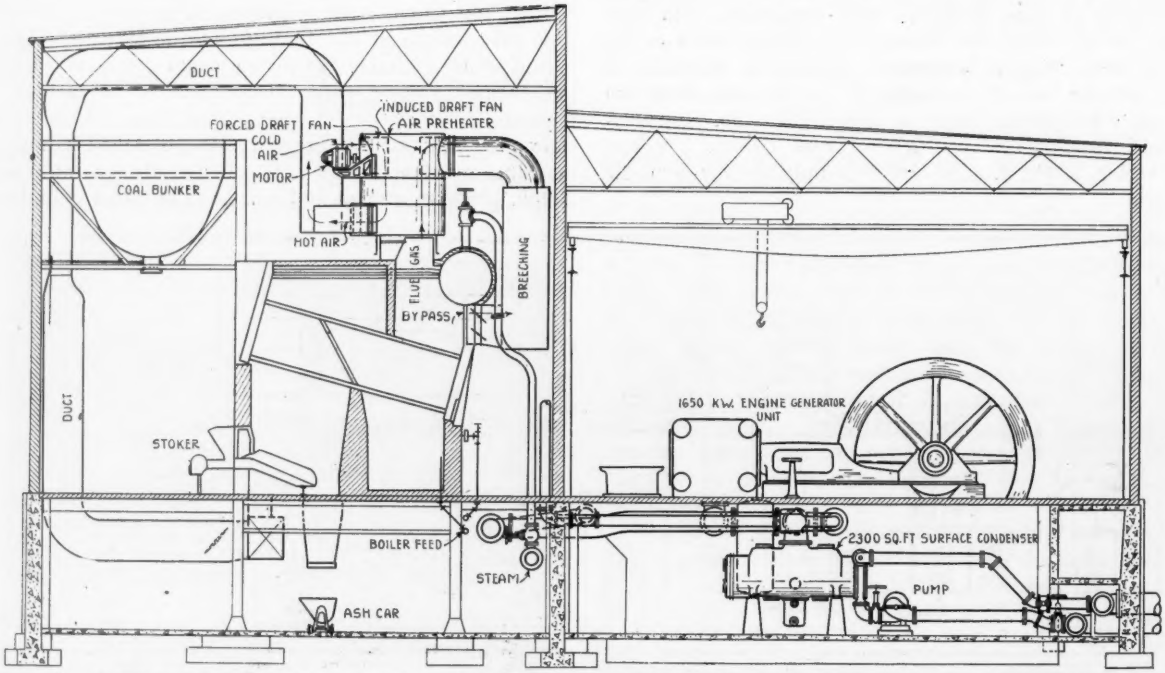


FIG. 4. CROSS-SECTION THROUGH PLANT ADDITION, SHOWING NEW ENGINE-GENERATOR UNIT AND ARRANGEMENT OF NEW BOILERS AND AUXILIARIES

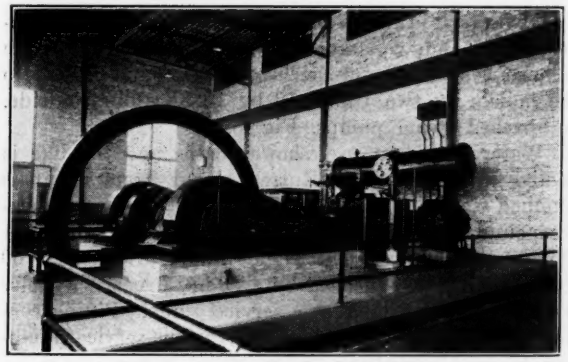


FIG. 6. NEW AIR COMPRESSOR UNIT, DRIVEN BY CROSS-COMPOUND ENGINE

with Copes feed water level controllers, Diamond soot blowers, Everlasting blowoff valves and Bailey meters.

AIR PREHEATERS SUPPLY 360-DEG. AIR TO NEW BOILERS

Each of the new boilers is equipped with a Ljungstrom Type C-14 air preheater, mounted above the boiler, as shown in Fig. 4. These preheaters each have a heating surface of 17,700 sq. ft. Between ratings of 100 and 200 per cent they are designed to take flue gas from the boilers at 450 to 525 deg., discharging it at 200 to 250 deg. and, with these gas temperatures, to draw in air at an average temperature of 70 deg. and send it to the furnaces at 360 to 380 deg. Both forced and induced draft fans are incorporated in the construction of the preheater; these fans, together with the rotary element, are driven from a 60-hp. motor installed on the unit as shown. At 200 per cent of boiler rating, with a draft at the forced draft fan of 6 in., including that necessary for forcing the air through the ducts, it is stated that the power consumption of the preheater is about 50 hp.

Coal used at the Kohler Co.'s plant is mostly Pittsburgh, Youghiogheny and split screenings, averaging about 13,200 B.t.u. per pound. Coal is not stored, except a few cars at a time. It is all brought to the plant by rail and is weighed in the cars. After weighing it is dumped into a track hopper, which loads a

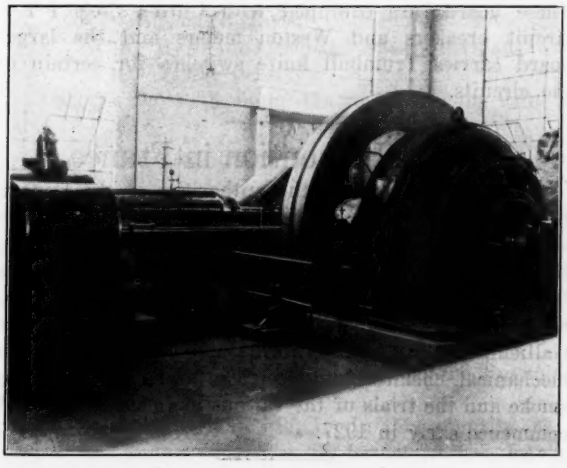


FIG. 7. ORIGINAL INSTALLATION INCLUDES THIS 500-KW. UNIFLOW UNIT

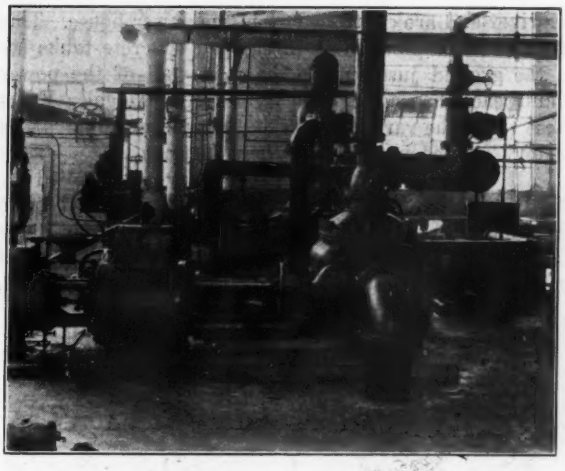


FIG. 8. BOILER FEED PUMPS, FIRE PUMP AND SERVICE PUMPS ARE GROUPED AT ONE END OF BOILER HOUSE

flight conveyor. This conveyor, with a capacity of 20 t. an hour, elevates the coal to a 400-t. steel coal bunker in the original boiler room and to a 150-t. steel bunker over the new boilers. From the bunkers the coal is spouted directly to the stoker hoppers of the original boilers, as in Fig. 9, and is handled by a weigh larry for the new ones, Fig. 3. Coal handling equipment was furnished by Link-Belt Co.

Ash from the stokers drops into hoppers under each furnace, from which it is dumped into industrial cars running under the hoppers, as in Fig. 4. These cars dump into a skip hoist bucket, which elevates the ash to a storage tank outside the plant. This ash handling equipment was designed and built in the Kohler Co.'s shops.

All water used for boiler feed and general domestic use in the factory is pumped from the Sheboygan River, about 2000 ft. from the boiler house by two De Laval 1500-g.p.m. centrifugal pumps, one driven by a d.c. Crocker-Wheeler motor and one by an a.c., 440-v. Crocker-Wheeler motor. The pumps are located near

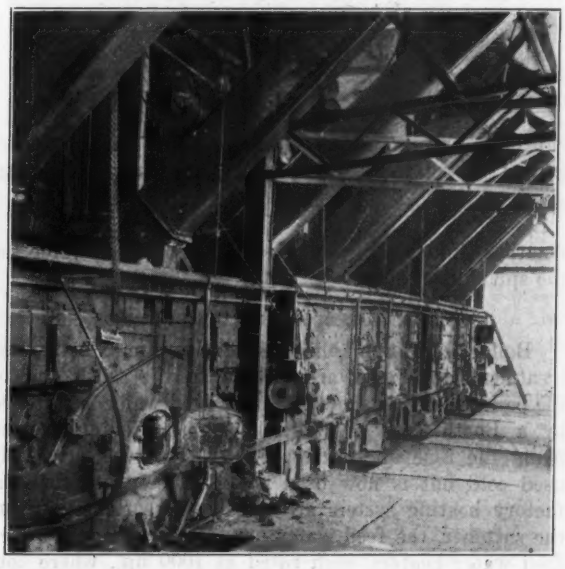


FIG. 9. SIX ORIGINAL BOILERS ARE SET IN PAIRS

the river and are controlled from the power house. This river water is pumped to three open concrete tanks set in the ground just outside the west wall of the power plant, each having a capacity of 100,000 gal. From these tanks the various condenser circulating pumps and factory service pumps take their suctions.

All drinking water for the factory is supplied by 500-ft. artesian wells. It is pumped by air lift from the wells into an 18,000-gal. tank; then a Union 10 by 12 by 14-in. steam pump sends it to a 100,000-gal. steel tank supported on a 100-ft. tower outside the plant.

FIG. 10. TWO NEW 520-HP. BOILERS UNDER ERECTION, SHOWING COAL BUNKER AND SUPPORT FOR PREHEATER

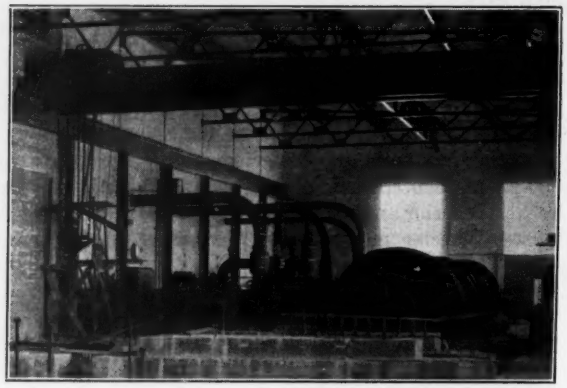


FIG. 11. ORIGINAL ENGINE ROOM CONTAINS THREE ENGINE-DRIVEN GENERATORS AND TWO ENGINE-DRIVEN AIR COMPRESSORS

Another similar tank holds a reserve of river water for the sprinkler system.

Boiler Feed Water Is Softened

Boiler feed pumps, heaters, service pumps and water treatment apparatus are located in the south end of the boiler room, as shown. Boiler feed water is softened by a Booth (now Permutit) water softening system, using the lime and soda process. This was originally used cold but is now used hot. All returns from the factory heating system are led to this softener. From the softener, the feed water passes to two Hoppes open feed water heaters, each rated at 1000 hp., where condensate from the main engine condensers is introduced. These heaters utilize mostly the exhaust from the uniflow engine but can also take exhaust steam from the exhaust header. From the heaters the water is sent to the boilers by two Union 16 by 10 by 16-in., outside, end-packed steam pumps, Fig. 8.

Water for plant use, shower baths and the like is heated by two Griscom-Russell closed heaters. It is pumped about the plant by a Union 1000-g.p.m., tandem-compound, 16 by 24 by 18 by 20 steam pump. A De Laval 750-g.p.m. centrifugal pump, driven at 1700 r.p.m. against 175-ft. head by a 50-hp. Crocker-Wheeler motor, is also available as a service pump. Piping connections are arranged so that the various service pumps can be used for filling the overhead storage tanks.

In the pump room is also installed a Fairbanks, Morse & Co. underwriter's fire pump. This is an 18 by 10 by 12-in. unit, designed to pump 1000 g.p.m. at 70 r.p.m. For handling the vacuum return lines of the factory heating system, two Union 12 by 24 by 20-in. vacuum pumps are installed.

All motors in the factory, with the exception of a very small section as noted, are wound for 230 v., d.c. Power is therefore sent direct to the factory at this voltage. For handling the feeder circuits a 14-panel switchboard is installed near the smaller engines and a new 4-panel board handles the circuits from the new 1650-kw. unit. The large board is shown in Fig. 12. These boards are equipped with Cutter Co.'s I T E circuit breakers and Weston meters and the larger board carries Trumbull knife switches for certain of the circuits.

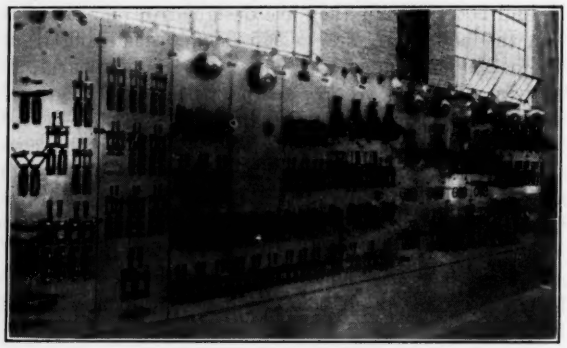


FIG. 12. GENERATOR AND FEEDER CIRCUITS ARE HANDLED FROM THIS SWITCHBOARD

Smoke Prevention in France

AT THE INSTANCE of the authorities of the Department of the Seine, the French Office National des Recherches et Inventions is organizing a competition for the best means of preventing smoke emission from factories. The competition, entries for which will be received by the Office National at the Avenue du Marechal Gallieni, Bellevue, Paris, until October 1 will extend to mechanical, chemical and electrical means of eliminating smoke and the trials of the various methods entered will commence early in 1927.

ECONOMY, or acceptance, tests of equipment are ordinarily made at the expense of the purchaser.

Studies of the Pumping of Viscous Liquids

IN DETERMINING THE KIND OF PUMP, THE HORSEPOWER, AND THE SIZE OF PIPE, THE IMPORTANT FACTORS TO BE CONSIDERED ARE — DENSITY, VELOCITY AND VISCOSITY.

BY M. P. O'BRIEN AND M. W. TODD*

EXPERIMENTS UPON the frictional resistance of water flowing in circular pipes have been quite exhaustive but unfortunately the theory underlying most of these experiments has not been sufficiently complete to allow the application of the results to other liquids. Researches of Osborne Reynolds and Stanton and Pannell on the determination of the criteria for similarity of motions of liquids flowing in pipes have provided engineers with a simple method of determining frictional losses. For ordinary pumping problems, the knowledge of a few physical constants is sufficient for an accurate determination of the resistance of any liquid. The present article was suggested by the following problem.

PRACTICAL PROBLEM IS WORKED OUT

With a sugar solution of generally undetermined physical properties and specific gravity of approximately 1.3; quantity, 5 gal. per min.; temp. deg. F., 77; diam. of pipe, 1 in. (copper); length of pipe, 40 ft.; vertical lift, 25 ft.; number of right angle bends, 3; what will be the pressure drop, the horsepower of motor required and the type of pump best suited for this work?

Solution of this problem is based upon the research of Osborne Reynolds and of Stanton and Pannell. Their investigations showed that the resistance per unit area could be expressed in terms of two dimensionless quantities which were:

$$\frac{Mig}{V^2} \text{ and } \frac{Vd}{K}$$

where

M = hydraulic radius
i = the slope of the hydraulic gradient
g = the acceleration of gravity
V = velocity of the fluid (distance per unit time)
d = diameter of the pipe
K = kinematic viscosity (kinematic viscosity is the absolute viscosity divided by the density).

Osborne Reynolds found that whenever the value of $\frac{Vd}{K}$ was the same, the ratio $\frac{Mig}{V^2}$ also would be the same regardless of the velocity, diameter of pipe or the physical properties of the liquid under consideration.

The practical value of this result is that V, d and K are quantities which may be readily determined, and once determined for a particular case, the corresponding value of $\frac{Mig}{V^2}$ may be taken from the Reynolds-Stanton curve shown in Fig. 1. In this quantity, M, g and V^2 are known or may easily be determined, leaving as the only unknown, i, the head loss per unit length.

*Instructors in Hydraulic Engineering, Purdue University.

Figures 2 and 3 show respectively the density and absolute viscosity of the sugar solution in question as determined by laboratory tests. The following table shows the kinematic viscosity as computed from these results:

Temp. Deg. C.	Sp. Gr.	Kinematic Viscosity
25	1.305	0.57 Cm.²/sec.
30	1.302	0.378 "
35	1.297	0.263 "
40	1.294	0.218 "
45	1.292	0.185 "
50	1.290	0.16 "
55	1.289	0.14 "
60	1.288	0.12 "

An essential characteristic to be noted in regard to the quantities $\frac{Vd}{K}$ and $\frac{Mig}{V^2}$ is that they are both dimensionless in terms of the fundamental units length,

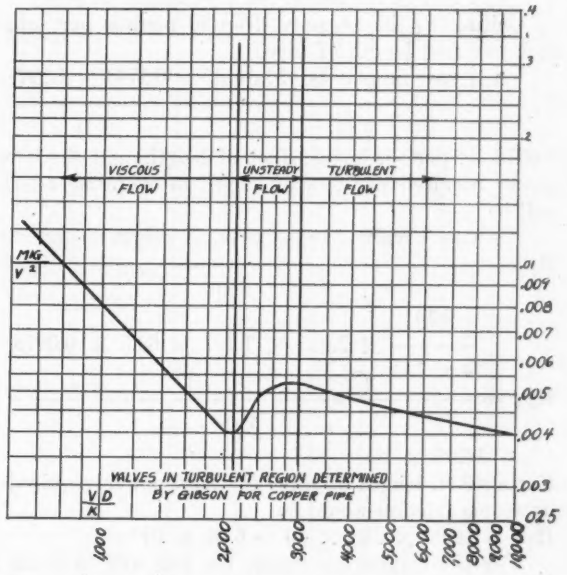


FIG. 1. THIS IS KNOWN AS THE REYNOLDS-STANTON CURVE AND IS USED FOR DETERMINING THE VALUES NECESSARY TO FIND THE HEAD LOSS PER UNIT LENGTH

mass and time and hence their value will be the same whether expressed in English or metric units. As absolute viscosity and density usually are expressed in the metric system, it was thought that $\frac{Vd}{K}$ should be worked out in this system although English units might have been used.

Solution of the problem is as follows:

$$Q = 5 \text{ gal. per min.} = \frac{5 \times 3785}{60} = 315.5 \text{ cm.}^3 \text{ per sec.}$$

$$A = \text{area of pipe} = \frac{3.14 \times 2.54^2}{4} = 5.07 \text{ cm.}^2$$

$$V = \frac{315.5}{5.07} = 62.4 \text{ cm. per sec.}$$

$d = 1$ in. $= 2.54$ cm.

$K = 0.57$ cm.^{2} per sec.

$$\frac{V\,d}{K} = \frac{62.4 \times 2.54}{0.57} = 278$$

From the Stanton-Pannell curve, $\frac{M\,i\,g}{V^2} = 0.028$

and expressing these quantities in English units

$$M = \frac{3.14d^2 \div 4}{3.14d} = \frac{d}{4} = \frac{1}{12 \times 4} = \frac{1}{48} \text{ ft.}$$

$g = 32.2$ ft. per sec.^{2}

$$V = 62.4 \text{ cm. per sec.} = \frac{62.4}{2.54 \times 12} = 2.045 \text{ ft. per sec.}$$

$$i = 0.028\,V^2 = \frac{0.028 \times 2.045^2 \times 48}{32.2} = 0.1744 \text{ (head loss}$$

in feet of the liquid per foot length of pipe)

Calling P_1 the pressure drop in pounds per square inch per foot length of pipe:

$$P_1 = \frac{i \times \text{specific gravity of liquid}}{2.31} = \frac{0.1744 \times 1.297}{2.31} =$$

0.0978 lb. per sq. in. per foot of length, and the horsepower required per foot of length to overcome friction will be

$$Hp_1 = \frac{\text{area} \times \text{veloc.} \times \text{spec. grav.} \times \text{weight of water} \times i}{550}$$

$$Hp_1 = \frac{\frac{3.14}{4 \times 144} \times 2.045 \times 1.297 \times 62.5 \times 0.0978}{550} =$$

$$16.06 \times 10^{-5}$$

For a 40-ft. length of pipe, the horsepower required to overcome friction would be

$Hp_f = 16.06 \times 10^{-5} \times 40 = 6.42 \times 10^{-3}$

For the right-angle bends, the loss will be equal to that occurring in a length of pipe equal to five times the diameter. Therefore,

$$Hp_b = \frac{5 \times 3 \times 1}{12} \times 16.06 \times 10^{-5} = 20.1 \times 10^{-5}$$

To lift the liquid through the vertical height of 25 ft., the horsepower required will be

$$Hp_v = \frac{\frac{3.14}{4 \times 144} \times 2.045 \times 1.297 \times 62.5 \times 25}{550} = 0.041$$

The total horsepower would be

$$Hp = Hp_f + Hp_b + Hp_v = 0.0476$$

For a very viscous, non-corrosive liquid the rotary pump is the most desirable. The action of a centrifugal pump is somewhat uncertain and the reciprocating pump has valves that are likely to stick. The efficiency of a rotary pump is around 50 per cent and the quantity of liquid pumped is approximately proportionate to the displacement and the speed. In setting the pump, the most important consideration is to maintain as great a pressure as possible on the suction side. This may be attained by placing the pump several feet below the surface level of the supply reservoir with only a short length of pipe on the suction side. There are several different types of rotary pumps admirably suitable for pumping the solution in question.

Development of Theoretical Equations

Resistance to motion of liquids flowing in pipes depends upon the density, viscosity and velocity of the liquid, and the diameter and roughness of the pipe. Application of the principle of dimensional homogeneity indicates that the general equation of flow is of the form:

$$\left\{\frac{M\,i\,g}{V^2}\right\} \text{ varies as } \left\{\frac{DV}{K}\right\}^x \left\{\frac{e}{D}\right\}^y$$

where M is the hydraulic radius; i is the head loss per unit length; g is the acceleration of gravity; V is the velocity of the liquid; D is the diameter of the pipe; K is the kinematic viscosity of the liquid; e is the average height of surface asperities.

If the dimensions in mass, length and time are substituted for the variables in the above equation, it will be found that each term included in parenthesis is dimensionless, therefore its value is independent of the units of measurement employed or the scale of the phenomena. The two members on the right are the criteria for similarity of motion and for all cases in which they have the same value the ratio $\left\{\frac{M\,i\,g}{V^2}\right\}$ will be found to be the same. The ratio $\left\{\frac{e}{D}\right\}$ is a measure of the surface roughness and its presence in the formula requires that the surface asperities be in proportion to the diameter for different pipes. In the following analysis, this condition is assumed to have been satisfied.

The term $\left\{\frac{VD}{K}\right\}$ is known as the Reynolds Number. Values of $\left\{\frac{M\,i\,g}{V^2}\right\}$ were plotted against this criterion as is shown in Fig. 1 and it was found that for fluids of as different properties as air, water and oil, equal value of $\left\{\frac{VD}{K}\right\}$ corresponded to equal values of $\left\{\frac{M\,i\,g}{V^2}\right\}$. The graph shows that as $\left\{\frac{VD}{K}\right\}$ is increased, the viscous or stream line flow changes to turbu-

lent flow at a value of about 2500, causing an abrupt increase in the resistance. This effect is shown in Fig. 1 and also in Fig. 6 on the curve of pressure drop against temperature for the ½-in. pipe.

The only unfamiliar factor entering into the criterion for similarity is the kinematic viscosity, which is the ratio of the absolute viscosity to the density. For many common liquids, this quantity may be found in tables of physical properties.

In case such information is not available, the absolute viscosity may be determined by means of one of the standard commercial viscometers, such as Redwood, Saybolt or Michell.

Viscosity is Important Factor

Maxwell's definition of viscosity states that "the viscosity of a substance is measured by the tangential force on a unit of either of two horizontal planes at a unit distance apart required to move one plane with unit velocity in reference to the other plane, the space between being filled with the viscous substance." Referring to Fig. 4, F is the force per unit area exerted along the plane CD, V is the velocity of the plane CD relative to AB, and S is the distance between the planes. Calling the viscosity u, the mathematical statement of the definition is

$$u = \frac{FS}{V}$$

The dimensions of u in terms of mass, length and time are $(M\ L^{-1}\ T^{-1})$.

Viscosity of a substance usually is expressed in terms of poises. Two planes at a distance of 1 cm. would be given a relative velocity of 1 cm. per second by a force of one dyne per square centimeter if the intervening space were filled by a liquid having a viscosity of one poise.

The viscosity of the sugar solution was made by means of the Ostwald viscometer. It is of the greatest importance in using this type of viscometer that the volume of liquid used should be the same for all tests. In using this instrument, the viscosity of the liquid is given by

$$u = d\left\{A\,T - \frac{B}{T}\right\}$$

where d is the density of the liquid; T is the time required for the liquid to flow from the upper to the lower mark on the tube; A and 8 are constants for a constant volume of fluid in a particular viscometer.

A and B are determined by running liquids of known viscosity through the instrument and noting the elapsed time T. In the viscometer used, these constants were determined by the use of distilled water and mercury. For A the average value obtained was approximately 0.0001 and for B, 0.065.

The quantity $\frac{B}{T}$ is negligible compared with A T

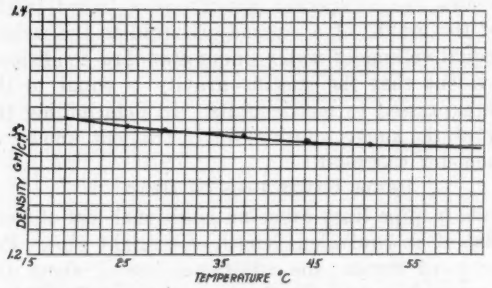


FIG. 2. THIS CURVE SHOWS THE DENSITY OF THE SUGAR SOLUTION AT VARIOUS TEMPERATURES

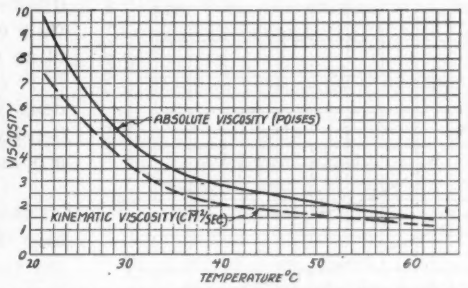


FIG. 3. ABSOLUTE AND KINEMATIC VISCOSITY ARE PLOTTED AGAINST TEMPERATURE IN THESE CURVES

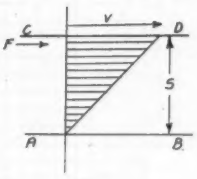


FIG. 4. GRAPHIC REPRESENTATION OF THE RESOLUTION OF FORCES NECESSARY TO CALCULATE VISCOSITY IS SHOWN BY THIS DIAGRAM

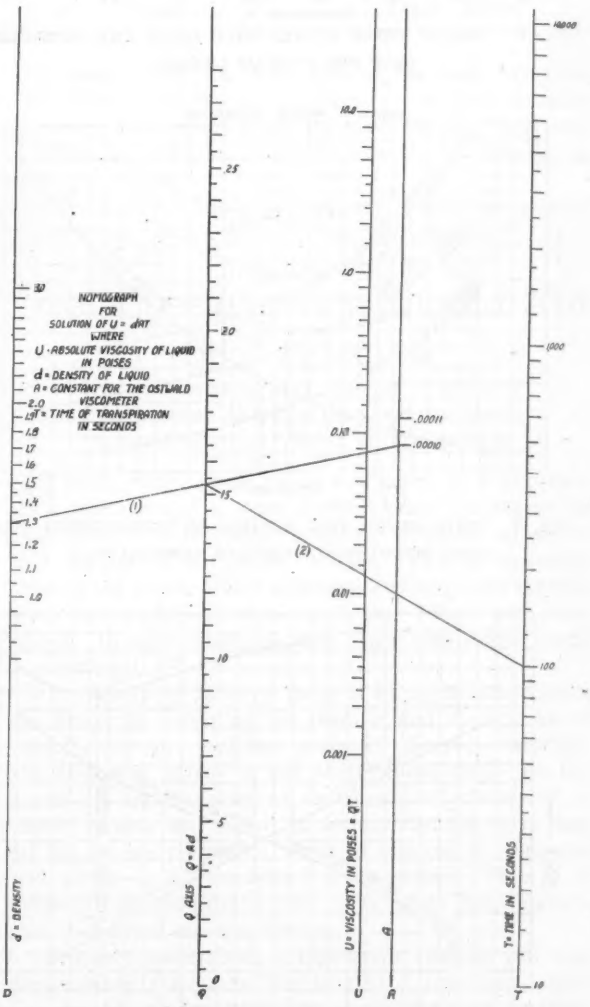

NOMOGRAPH FOR SOLUTION OF U = dAT WHERE
U = ABSOLUTE VISCOSITY OF LIQUID IN POISES
d = DENSITY OF LIQUID
A = CONSTANT FOR THE OSTWALD VISCOMETER
T = TIME OF TRANSPIRATION IN SECONDS
(1)
(2)
d = DENSITY
Q = Ad
U = VISCOSITY IN POISES = QT
T = TIME IN SECONDS

FIG. 5. BY USE OF THIS NOMOGRAPHIC CHART NECESSARY VALUES OF VISCOSITY MAY BE DETERMINED. CONNECT LINES A AND D. FIND POINT OF INTERSECTION ON Q. RUN A LINE FROM HERE TO PROPER POINT ON T. READ VALUE OF VISCOSITY WHERE LINE (2) INTERSECTS U

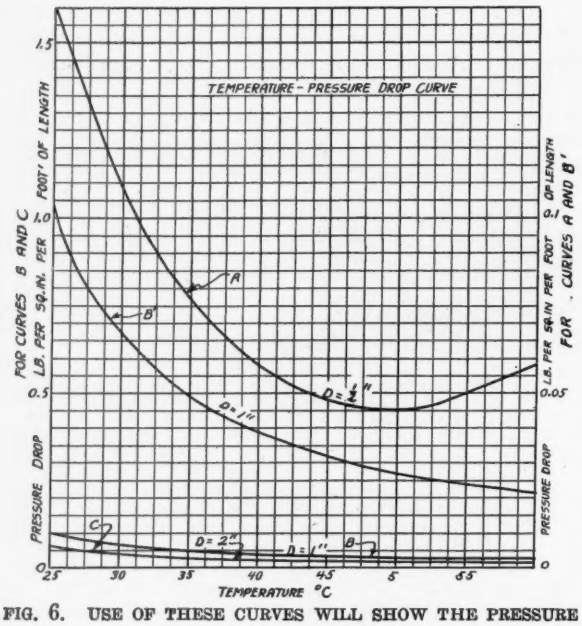


FIG. 6. USE OF THESE CURVES WILL SHOW THE PRESSURE DROP PER FOOT OF LENGTH

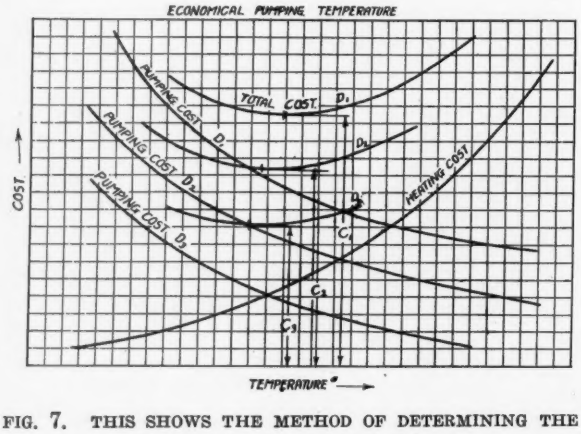


FIG. 7. THIS SHOWS THE METHOD OF DETERMINING THE MOST ECONOMICAL PUMPING TEMPERATURE

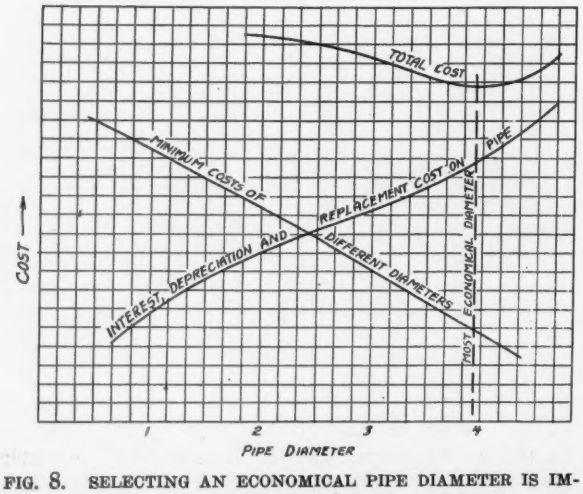


FIG. 8. SELECTING AN ECONOMICAL PIPE DIAMETER IS IMPORTANT AND THE METHOD IS SHOWN HERE

and may be neglected giving

$$u = d\,A\,T$$

A nomographic chart used in solving this equation is shown in Fig. 5.

Density is defined as the mass per unit volume. In the metric system the unit of mass is the weight of a cubic centimeter of water under certain standard conditions and as the specific gravity of a liquid is the ratio of the weight of a volume of liquid to the weight of an equal volume of water under standard conditions, it is evident that the specific gravity is equal to the density expressed in metric units. In determining the density of the sugar solution, an instrument known as a pyknometer was used.

Bends Cause Loss of Head

Bends in pipe lines cause an additional loss of head over that of an equivalent length of straight pipe. For the turbulent region, the additional loss is about the same as would occur in 30 diameters. At smaller values of $\left\{\frac{VD}{K}\right\}$ this additional loss decreases and for $\left\{\frac{VD}{K}\right\}$ less than 100 an average value of 5 diameters may be used.

For entrance losses, the values $0.47\,\frac{V}{2g}$ and $0.47\,\frac{V^2}{2g}$ are used for stream line and turbulent flow respectively. At sudden enlargements, the loss can be worked out on the assumption that all of the reduction in velocity head is dissipated. This gives a loss in excess of the actual value, therefore it is on the side of safety. In most pumping problems, these losses are of minor importance. It is evident from the curves shown in Fig. 6 that an increase in temperature reduces the frictional resistance. For curves A and B showing the pressure drop for pipes with diameters of ½ in. and 1 in. respectively, use the left-hand scale for pressure drop. Curve B¹ also is for a pipe with a diameter of 1 in. and the right-hand scale of pressure drop is to be used. This scale, also is to be used for curve C for a pipe diameter of 2 in.

Finding an Economical Pumping Temperature

The method of determining the most economical temperature is indicated in Fig. 7. The cost of heating the liquid depends upon the available source of heat, the specific heat of the liquid, the conductivity of the pipe material and the temperature of the air. The cost of power depends upon local conditions. The most economical pumping temperature for a given pipe diameter is of course the point at which the sum of the pumping and heating costs is a minimum.

Finding the Diameter of Pipe

Choice of a diameter depends upon the cost of pipe. The method of determining the economical diameter is indicated in Fig. 8. After this diameter has been chosen, the corresponding curve of pumping cost should be worked out and the economical pumping temperature for that pipe size chosen.

Figures 7 and 8 do not show actual values but are ideal curves used merely to point out a method of solution.

Fuel Sizing for Chain Grate Stoker

ASH PIT LOSS HELD TO MINIMUM BY PROPER CRUSHING AND SIZING OF COAL. BY F. C. DUENNES

THIS ARTICLE is intended to show the importance of proper fuel sizing for chain grate stokers. Let us make a study of the curves shown in Figs. 1 and 2. These curves were plotted from data obtained from a

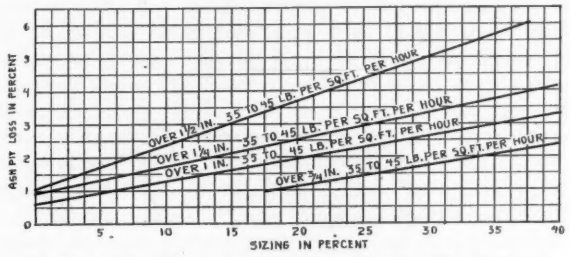

ASH PIT LOSS IN PERCENT
SIZING IN PERCENT
OVER 1½ IN. 35 TO 45 LB. PER SQ.FT. PER HOUR
OVER 1¼ IN. 35 TO 45 LB. PER SQ.FT. PER HOUR
OVER 1 IN. 35 TO 45 LB. PER SQ.FT. PER HOUR
OVER ¾ IN. 35 TO 45 LB. PER SQ.FT. PER HOUR

FIG. 1. RELATION OF ASH PIT LOSS TO SIZE OF COAL

large number of evaporation tests in which the coal-sizing conditions were taken into account. These curves show clearly how the sizing of the fuel affects the ash pit loss. By ash pit loss we mean that part of the combustible in the coal which was not completely burned and has passed over the end of the stoker into the ash pit along with the refuse.

Referring to the curves shown in Fig. 1, each having the same rate of fuel consumption, the tendency is toward higher ash pit losses as the coal increases in size. For instance, coal with 10 per cent over one inch will

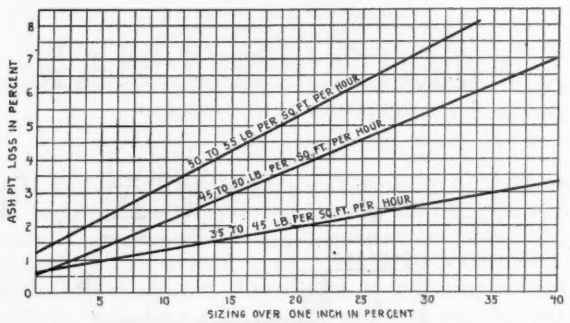

ASH PIT LOSS IN PERCENT
SIZING OVER ONE INCH IN PERCENT
50 TO 55 LB PER SQ.FT. PER HOUR
45 TO 50 LB PER SQ.FT. PER HOUR
35 TO 45 LB PER SQ.FT. PER HOUR

FIG. 2. VARIATION OF ASH PIT LOSS WITH RATES OF COMBUSTION

give a loss of about 1.3 per cent while a coal with 10 per cent over 1½ in. will give a loss of about twice as much. In comparing these curves, the critical size is directly shown to be less than one inch; but in the attempt to crush all the coal to ¾ in., the percentage of fine coal, that is coal less than ¼ in. in size, is greatly increased. This condition is also objectionable.

The tendency toward higher ash pit losses as the coal is coarser is also proportional to the rate of fuel consumption. Referring to the curves shown in Fig. 2, with the same fuel sizing but burning at different rates, the tendency is for the higher rate of fuel consumption to result in higher ash pit losses. For instance, with 10 per cent over one inch will give a loss of 1.3 per cent at a 35-lb. coal rate, while at a 50-lb. coal rate the loss will be more than double.

These curves will vary with the different types of stokers; being higher with natural draft stokers than with forced blast stokers, but the tendency is the same.

Burning coarse coal may introduce another loss, that of excess air through the fuel bed. But with competent firing this loss can be controlled within limits by proper manipulation of the grate speed and air supply.

The CO_2 can be controlled with possibly a slight decrease in capacity so that the excess air is no more with coarse coal than with coal of the most favorable size when considered on the basis of actual combustible burned. The correct sizing therefore resolves itself into a minimum above one inch and a maximum from ½ in. down.

CRUSHING TEST WITH SOUTHERN ILLINOIS LUMP COAL

	Pounds	Per cent
Sizing over 1½ in.....	1.5	1.06
Sizing over 1¼ in.....	2.0	1.40
Sizing over 1 in.....	7.0	4.91
Sizing over ¾ in.....	15.0	10.58
Sizing over ½ in.....	28.0	19.73
Sizing over ⅜ in.....	21.0	14.81
Sizing over ¼ in.....	23.0	16.21
Sizing under ¼ in.....	44.0	31.30
Total	141.5	100.00

The results of a test made on a crusher recently installed are shown in the accompanying table.

Over-Speed Device Should Not Be Neglected

SERIOUS DAMAGE MAY RESULT IF SAFETY PRECAUTIONS ARE NOT OBSERVED ON HIGH-SPEED MACHINES. BY J. J. MCDOUGALL

MANY MEN while being instructed in the proper operation of a steam turbine plant wonder at the insistence of instructions regarding frequent inspection and testing of the safety devices. This is especially true of the device which automatically trips the throttle when the machine develops much over 10 per cent overspeed. In some machines only 5 per cent excess speed is permitted.

In high-speed turbines made of high-grade materials, the factor of safety in the blading and discs is about three, while in machines made of cheaper materials, the factor of safety is not much above two. As the stress developed varies as the square of the speed, a small increase may result in serious damage or it may set up severe vibrations which if allowed to continue will result in the machine being wrecked. Thus it is evident that precautions must be taken to make certain that over-speed can not develop.

Properly maintained, a high-grade turbine will run continuously for years, the length of time depending considerably on the reliability of the auxiliary machinery. It is when running for long periods of time that dangerous conditions usually develop in the safety devices, because they cannot be tested while the turbine is running under load. Often after long runs the over-

speed device will be found to work very sluggish if at all, or at least not within the safe limit. It pays to take a machine off the line at regular intervals to inspect the device to see if it is in first-class condition and see that it operates automatically when overspeeded.

Time Spent Inspecting Over-Speed Trip Not Wasted

Results of such neglect is brought out by a wreck occurring several years ago. What actually happened is difficult to find out, but from various reports and observance of the operating methods used in the plant, there is no doubt that all safety devices were neglected and that the over-speed device did not function when the governor failed. The plant consisted of three high-speed, vertical turbines, all running 24 hr. a day and seven days a week. Satisfaction was expressed with the reliability of the machines and it was claimed that in one year's run one turbine lost only 25 minutes. It is evident from this that no time was lost in testing or inspecting safety devices.

On the day of the accident, the turbines dropped the entire load, due no doubt to exciter trouble, as all three machines were served by one exciter. Two of the machines tripped out but the third one failed to do so after the governor failed to hold down the speed due to leaky valves or a sluggish pilot valve. Examination of the other two machines later showed that one could not be synchronized with the other unless the speed was reduced by using the hand throttle, the governor could not control the speed on no load, while the governor of the other machine became inoperative at some loads, the pilot valve sticking badly. Neither of the over-speed devices were in the condition they should have been.

Vibrations Heavy Enough to Be Felt Outside of Plant

Evidently the third machine speeded up to a critical speed and vibrated so heavily the rotor started to pound against the stator. Instead of tripping the throttle the operator left the plant hurriedly, while a man outside the plant, hearing the noise, rushed to trip the machine and arrived at the throttle just as the generator went to pieces. The shaft broke a short distance above the turbine; laminations, coils, large pieces of cast iron and the broken shaft were hurled all over the plant, the man at the throttle being instantly killed. Holes were knocked in both ends of the building and the switchboard wrecked.

Such incidents can be entirely avoided by proper care involving little work. Men who neglect the governor and other safety devices of high-speed turbines or other high-speed machines are flirting with death.

It is only 47 yr. ago that the first attempt was made to light a room by means of incandescent electric lamps. It was at Harry Hill's, Houston St., New York City, where John L. Sullivan used to box. Today, electric light and power do a business of $7,500,000,000 a year and Thomas A. Edison, who was father of the electrical industry is alive to see the progress of the lusty giant for whom tremendously bigger things are now in sight.

Gas Producer and Steam Boiler Combined

By Chas. J. Webb

In the textile and other industries there are many concerns who would consider the question of electrification of their factories were it not for the fact that they require steam for certain operations and cannot wholly dispense with their boiler plant. A British concern has recently provided a solution to this problem in what is termed its "producer boiler." It is claimed that the system is extremely economical in space requirements and demands less skill and labor in operation than the ordinary system of firing. Another important feature is, the inferior classes of fuel may be

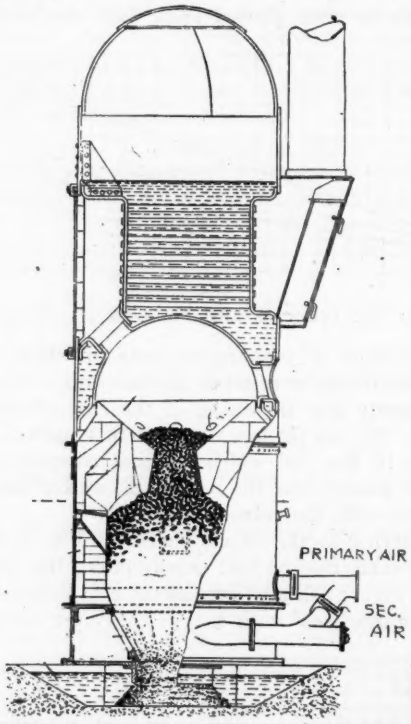


FIG. 1. PRIMARY AIR AND PREHEATED SECONDARY AIR ARE SUPPLIED BY THE SAME FAN

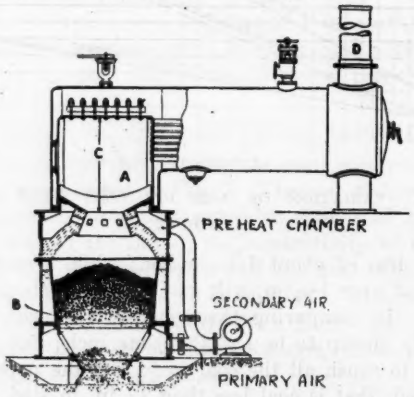


FIG. 2. THE BOILER IS SET DIRECTLY OVER THE GAS PRODUCER AND COMBUSTION TAKES PLACE IN TWO STAGES

used, costing in some instances less than half the price of the boiler coal. Coke breeze and smudge which could not be used in ordinary types of boiler furnace have been successfully burned.

High combustion efficiency is claimed and where 10 or 12 per cent carbon dioxide in the flue gases is considered good in a normal boiler installation, the producer boiler, owing to better conditions, is stated to show an average carbon dioxide value of 17.5 per cent.

In principle the producer boiler consists of a boiler mounted directly over a gas producer furnace. In its present form the producer furnace is being applied to boilers of the locomotive type, Fig. 1, and to vertical boilers of from 3 ft. up to 8 ft. 6 in. in diameter. Figure 2 shows the latter type boiler fitted with a producer furnace. It will be seen that the normal fire grate is dispensed with and that the crown of the producer is perforated with a number of gas ports. Joining up with each of the latter is an air port supplying preheated air. The resulting effect is a series of bunsen burners, the gas being burned as it is produced. Air is supplied by a small fan consuming from ¾ to 5 hp. per boiler according to the size and can be independently and accurately controlled by dampers. Producers are of the water-bottom type and ash can be withdrawn periodically from the bosh in the usual way.

Fuel is really burned in two stages, the first stage being effected in the producer itself where the fuel is converted into a combustible mixture of gases and the second stage in the boiler furnace where the gases are burned with a suitable admixture of secondary air. From a more practical consideration of the producer boiler it will be apparent that there is very little skill required in firing, merely the filling up of the producer as the fuel level falls while once the air controls are correctly set there is little occasion to disturb them. Burning fuel in this way shows a complete absence of visible smoke and tall chimneys are not needed. In the accompanying table, results of tests carried out with both a Cornish boiler and economizer and a locomotive type producer boiler, both arranged for an equal steam output, are given.

RESULTS OF A COMPETITIVE TEST OF THE PRODUCER BOILER WITH A CORNISH BOILER OF ABOUT THE SAME SIZE

	Producer Loco. Boiler	Cornish Boiler
Total heating surface	590 sq. ft.	520 sq. ft. (with economizer)
Fuel	Coke Breeze	Boiler Slack
B.t.u. required in fuel per hr.	5,568,000 at 75% efficiency	6,424,600 at 65% efficiency
Total surface exposed to radiant heat	86 sq. ft.	44 sq. ft.
Average time of contact of air with fuel	6½ sec.	1/3 sec.
Maximum distance gases travel before contact with chilling surface.	48 in.	21 in.
Average CO_2 in chimney gases	17.5	11

MAN Engine Tested Under Severe Conditions

High Overload and Overspeed Tests Give Important Data on Diesel Performance

FUEL REQUIREMENTS and capacity of a Diesel engine of the jet spray and "open" nozzle type were recently determined by the Augsburg-Nuernberg Co., according to an account in the V. D. I. Zeitschrift. One of their solid injection, six-cylinder MAN-Diesel engines, built for passenger ship service, was used for this test. It is rated at 296 brake horsepower at 180 r.p.m. with a maximum guaranteed fuel consumption of 0.392 lb. per b.hp-hr.

This single-acting, four-cycle engine has 13.58 in. diam. cylinders with a stroke of 19.68 in., Fig. 1 showing cross-sectional views and general construction features. The bedplate is far above the center of the crankshaft. This feature, including the design of the crank and of the reversing shafts, is a further development of the design which had proven itself exceedingly solid and resistive in submarines.

Spur gears transmit power from the crankshaft to the reversing shaft. The cams on the reversing shaft actuate admission, discharge and starting valves by means of hollow thrust rods. Fuel oil pumps, actuated by cams on the same shaft, are adjustable to enable easier regulation of the oil feed. Each fuel oil pump cylinder is built in one piece from wrought steel and bolted to the cylinder frame independent of the others. It was not deemed advisable to arrange all fuel oil pumps on one pump frame as this would have impaired accessibility and complicated operation.

Pressure Lubrication Used Throughout

All wearing parts, including the reversing shaft and gears, are pressure lubricated. Oil is drawn from the collecting basin below the engine by a rotary pump operated direct from the engine, forced through a filter and into the pressure system. Reversing is accomplished by axial movement of the reversing shaft, engaging cams for either backward or forward movement.

Fuel oil is forced from the fuel pump through a heavy pipe direct to a fuel nozzle of the so-called open type. The only resistance offered is that of the narrow discharge orifice of the nozzle. According to the designer this gives an exceptionally smooth running engine. Danger of clogging is eliminated by filtering the oil and carbon deposits are eliminated by a jet of scavenging air admitted after the fuel. Cams actuate the fuel pump plunger and oil above the requirements of the cylinder is returned to the pump suction chamber.

Cooling water for the engine was furnished by a

circulating pump with independent drive. Heat losses were based upon the flow from the engine and the temperature difference between the incoming and outgoing water. Fuel oil of about 31 Be. and 18.043 B.t.u. per lb. was used for the tests, measurements of weight being taken from stop watch and calibrated tank readings.

Complete Tests Shown Graphically

Tests were made to determine the quantity of fuel oil and cooling water required at 200, 250 and 300 r.p.m.

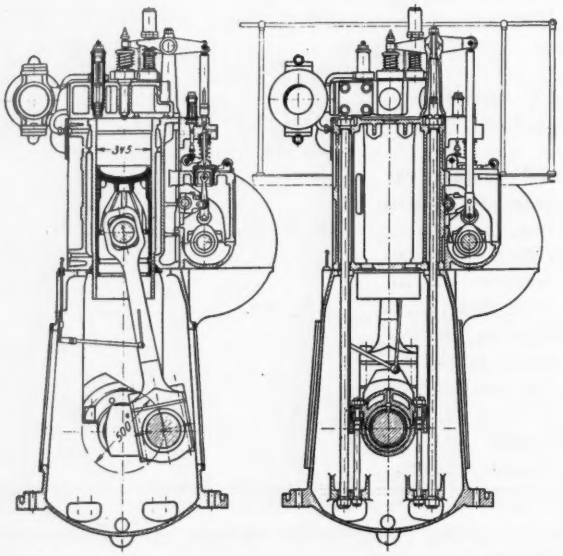


FIG. 1. CROSS-SECTIONAL VIEWS THROUGH AND BETWEEN ENGINE CYLINDERS

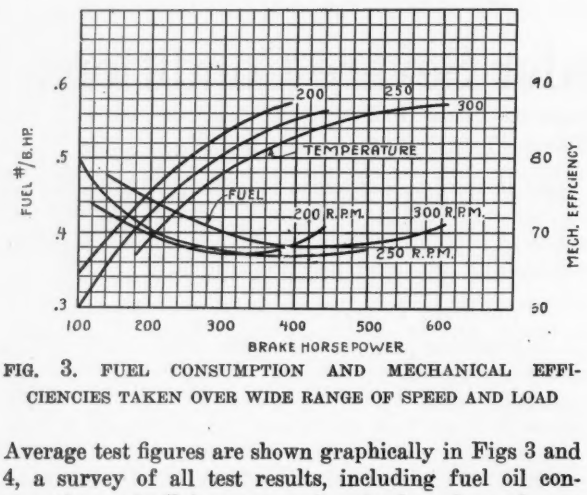


FIG. 3. FUEL CONSUMPTION AND MECHANICAL EFFICIENCIES TAKEN OVER WIDE RANGE OF SPEED AND LOAD

Average test figures are shown graphically in Figs 3 and 4, a survey of all test results, including fuel oil consumption and efficiency at various loads and speeds, exhaust temperature and heat removed in the cooling water. Starting diagrams, Fig. 2A, show how rapid the tested cylinder came to ignition, while the indicator cards, Fig. 2B, give an idea of combustion at 120, 100, 75, 50, 25 and 0 per cent load. No abnormally high cylinder pressures are evident in any of the cards. During the entire tests the exhaust was clear except at 20 per cent overload and 300 r.p.m. when a light haze appeared. This is not surprising since it was operating at 300 r.p.m., developing 603 hp., 60 per cent overspeed and 22 per cent overload.

During these tests, although the injection nozzle orifices were exceptionally small, about 0.006 in. diameter, there was no trouble with clogging. In order to determine the amount of time lost, in case clogging should occur, however, one cylinder was shut off while the engine continued under the same load. The nozzle was removed, replaced and ignition again effected in 3 min. and 40 sec.

Two of these engines are now in the passenger ship "Jan Molsen" which completed its test trip from Cux-

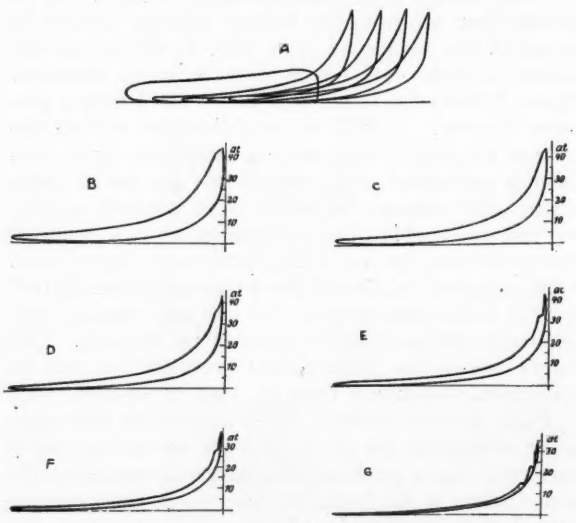


FIG. 2. PERFORMANCE OF ENGINE UNDER VARIOUS CONDITIONS AS SHOWN BY INDICATOR

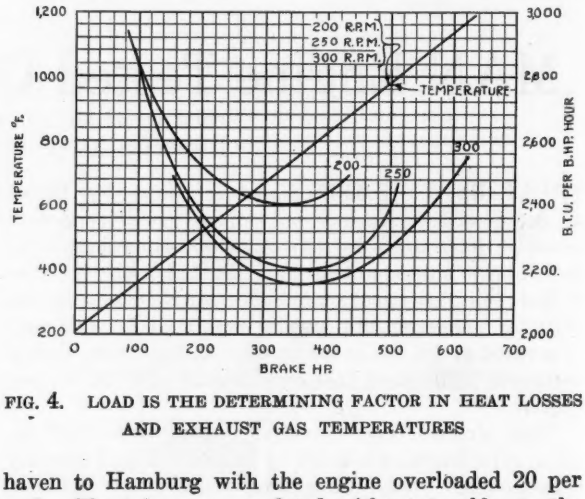


FIG. 4. LOAD IS THE DETERMINING FACTOR IN HEAT LOSSES AND EXHAUST GAS TEMPERATURES

haven to Hamburg with the engine overloaded 20 per cent. The trip was completed without trouble, to the entire satisfaction of all interested, as the speed of the ship, as conditioned in the sale, was exceeded by about two knots.

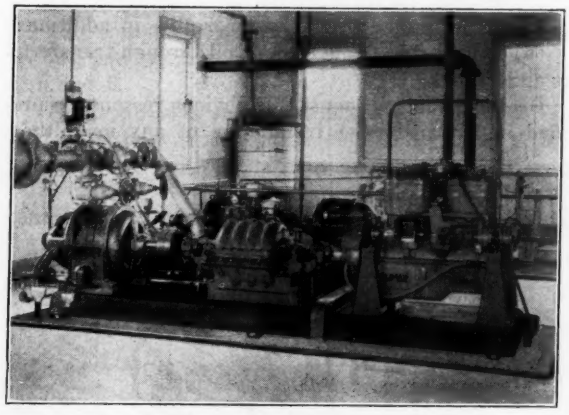
Underground mains should have the location of flange joints marked on the ground surface, by an iron rod, a stone set in the pavement or other means easily identified, in case repairs or alterations are necessary.

Air cylinders require about one-quarter as much oil as a steam cylinder of the same size.

Gasoline Engines as Stand-by or Emergency Power

By G. S. Hamilton*

STEADY GROWTH in the use of gasoline engines for industrial power purposes has taken place during the past few years. The old-fashioned steam dinky has been replaced by the modern gasoline locomotive, a sturdy, powerful and economical unit. In roads, streets and field, growth in the use of gasoline cranes and shovels has been large. There is reason for this growth. The industrial gasoline engines of today have been definitely designed for the work for which they are intended. They are no longer revamped automobile motors, but heavy duty, medium speed engines, of sturdy and powerful construction. Large stationary power gasoline units, intended principally for stand-by service, are now being installed for driving pumps and generators.



INSTALLATION PERMITTING RAPID INTERCHANGE OF GASOLINE ENGINE POWER AND ELECTRIC POWER AT THE WILLISTON, SO. DAKOTA WATER WORKS

About two years ago the city of Williston, South Dakota, installed a pump direct connected to a gasoline engine and an electric motor at its water works. For every-day service, the pump was driven by an electric motor, as the cost of electricity was reasonable. But it was realized that storms and other causes beyond human control might cause a failure in the supply of electric power. To guard against this, the installation indicated was made.

To cite another instance of the use of gasoline engines as emergency power, The Radio Corporation of America maintains at Chatham, Mass., a transmitting station which keeps in constant touch with vessels at sea. Power for operating the equipment is normally furnished by a line from the Central Station serving this section of Cape Cod. Violent storms, however, make it advisable to maintain a stand-by set for generating electricity. For this purpose a four-cylinder gasoline engine, direct connected to a 40-kw. generator, was installed.

Many manufacturing plants depend entirely upon outside pressure to provide water for fire fighting. It is now recognized as good practice to safeguard property by the installation of an independent fire fighting system. The use of gasoline engines for driving fire pumps has been recognized by the Underwriters, who have noted the reliability and efficiency of this source of power. Within the past few months the Underwriters Laboratories, Chicago, listed as standard for driving 750 and 1000-gal. multistage centrifugal fire pumps, two models of gasoline engines.

In certain industrial plants where power is purchased, a gasoline engine-generator set is used to meet peak loads, thus reducing the power costs which normally are based on the maximum power requirements rather than on the amount of current used. The Allamarkee Drainage District in Northern Iowa has purchased a four-cylinder engine for pumping. This engine is used only a few months of the year during the season of high water.

Artificial ice companies have found it good business to install gasoline engines for stand-by service. The Ball Ice Machine Co. of St. Louis operates with purchased power. A gasoline engine is used as stand-by power. When the Prentiss Ice Co. of Prentiss, Miss., purchased stand-by equipment, they bought a similar machine.

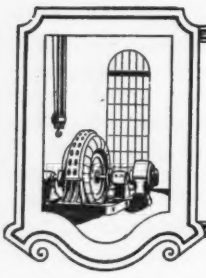
*Of the Climax Engineering Co., Clinton, Iowa.

Chlorine Keeps Tubes Clean

AS A RESULT of experimental work on the value of chlorine in preventing the growth of incrusting organic material in condenser tubes which was begun in England in 1922, a number of installations are now in operation in the United States. About a dozen large power stations in England are also using this system.

Experimental work on this system was first done in this country in 1924, in the Northwest plant of the Commonwealth Edison Co., results being reported to the N. E. L. A. It was found that a chlorine dosage of about 4 lb. of chlorine per million gallons of condenser cooling water was sufficient to prevent the growth of slime on the water side of condenser tubes and the advantages gained were sufficient to pay for the cost of the chlorine and show a balance on the favorable side. These advantages were, better heat transfer, reduction of labor charges for cleaning of tubes, better vacuum maintained. Cost of chlorine varies from 5 to 7½ cents per lb. depending on the quantity purchased, which would make the cost for chlorine about 20 to 30 cents per million gallons treated.

At the Crawford Ave. Station of the Commonwealth Edison Co. a similar problem is being handled in cooling the air for generator ventilation. This cooling air is blown through the generator and in turn is cooled by passing over pipe coils through which water is circulated, the water being chlorinated in order to keep the cooling coils free of slime. Figures are not available as to the cost of operation but it is understood that the results have been satisfactory. The process has been developed largely by Wallace & Tiernan Co., Inc., of Newark, N. J., who have worked out a special vacuum type chlorinator for introducing the chlorine into the water.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Transformer Oil Handling in Power Plants

EQUIPMENT USED IN MODERN INSTALLATIONS AND METHODS OF USING IT. BY ERIK G. SOHLBERG*

OIL USED as an insulating and cooling medium in electrical apparatus has its greatest application in power transformers. Frequently the number and sizes of transformers in any one installation are so large that the total quantity of oil involved becomes quite appreciable, a condition which requires special equipment for convenient handling and purification of the oil. In relatively smaller installations similar facilities will be found convenient and of economical advantage. The purpose of this article is to set forth the general extent and requirements of the oil handling equipment for transformer installations of varying number and sizes of units.

Fundamentally the equipment consists of such pumps, filters, storage tanks and piping as are necessary to transport, store, test, filter and circulate conveniently, the oil as demanded by reliable operation.

The essential operating requirements of the equipment in order of importance are as follows:

(1) *Draining* of any one transformer or storage tank.

(2) *Filtering* the oil in any one transformer, in the storage tank, from storage tank to transformer, or from barrels.

(3) *Draining* the storage tanks of sludge and sediment.

(4) *Quick filling* of any transformer either from storage tank or from barrels.

(5) *Storing oil* for make-up.

Forced oil cooled transformers require in addition:

(6) *Continuous circulation* of oil through transformers and coolers.

Draining facilities must, for obvious reasons, be provided in a transformer installation of any magnitude.

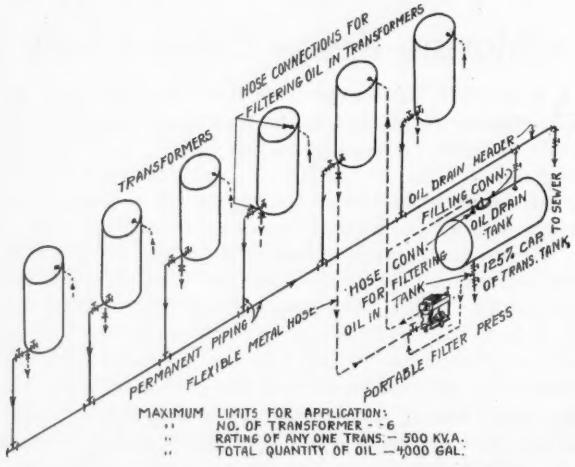

HOSE CONNECTIONS FOR FILTERING OIL IN TRANSFORMERS
TRANSFORMERS
OIL DRAIN HEADER
FILLING CONN.
OIL DRAIN TANK
TO SEWER
HOSE CONN. FOR FILTERING OIL IN
TANK
125% CAP. OF TRANS. TANK
PERMANENT PIPING
FLEXIBLE METAL HOSE
PORTABLE FILTER PRESS
MAXIMUM LIMITS FOR APPLICATION:
" NO. OF TRANSFORMER - 6
" RATING OF ANY ONE TRANS. — 500 KV.A.
" TOTAL QUANTITY OF OIL — 4,000 GAL.

FIG. 1. DIAGRAM OF OIL PIPING AND EQUIPMENT FOR SMALL OIL-FILLED SELF-COOLED TRANSFORMER INSTALLATION

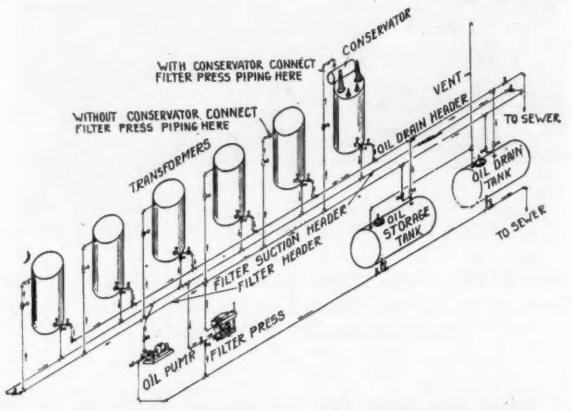


FIG. 2. DIAGRAM OF OIL PIPING AND EQUIPMENT FOR LARGE OIL-FILLED SELF-COOLED TRANSFORMER INSTALLATION

Local ordinances in some larger cities require it for protection, so that in case fire threatens from sources external to the transformer, the oil may be moved to a safe place or entirely removed from the premises as quickly as possible.

Fire is seldom started from abnormal internal conditions. The oils used ordinarily have a high flash point temperature and therefore ignite with difficulty. In addition, they have high specific heat and rapidly decreasing viscosity with rising temperature, the result being improved circulation and quick transfer of heat to the cooling medium. Practically all danger of fire from over-heating is thus eliminated, except possibly under severe sustained overloads, against which proper automatic switching protection is generally provided.

In medium and large size transformers, even this danger is eliminated by completely filling the transformer with oil and providing external expansion tanks.

Under certain conditions of overload or short circuit,

*Construction Engineering Department, General Electric Co., Schenectady, N. Y.

which for some reason cannot be interrupted, it may be difficult to decide whether or not to drain a transformer of its oil. For instance, draining the oil from a transformer exposes additional surfaces, aids vaporization and draws in fresh air, all of which enhances fire risk. On the other hand, if fire really threatens from some source or other, any appreciable quantities of oil must be removed.

The proper method to pursue then must be based on the merits of each individual case. Generally speaking, the best practice is, no doubt, to drain a transformer of its oil only as a last resort to prevent spreading of fire.

The equipment required for the draining operation is:

(a) A normally empty drain tank of sufficient capacity to hold all oil from the largest transformer in the installation.

(b) A drain header connecting the transformer tanks with the drain tank.

(c) A bypass connection to sewer.

This equipment is common to all transformer installations, and is diagrammatically indicated in Figs. 1, 2, 4, 5 and 6.

The drain tank should be located in a fireproof pit, preferably outside the station walls and at a lower level so that all oil will flow to it by gravity from any transformer tank. It should be slightly tilted towards drain connection in the bottom located near one end so that

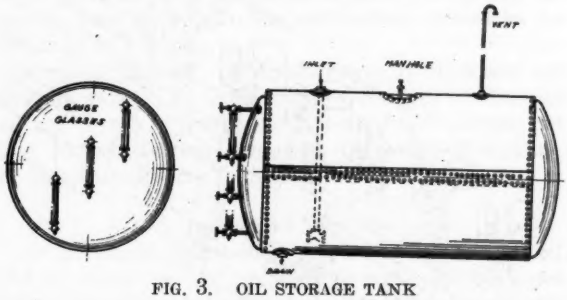


FIG. 3. OIL STORAGE TANK

it can be completely emptied, also that any large quantity of water may collect here and be withdrawn before attempting to filter. The inlet pipe should extend to within six inches of the bottom to prevent aeration of the oil as it enters the tank. An oil-tight manhole and cover of liberal dimensions, a small air vent extending above the level of oil in transformers and gage glasses, as shown in Fig. 3, should be provided.

The drain header should be made of pipe at least one size larger than the largest transformer outlet, so as not to retard the draining operation. A bypass to sewer is provided for emergency use.

Filtering facilities are essential to the satisfactory performance of transformers, as well as other oil insulated apparatus. In spite of all precautions, oil may absorb moisture and form sediment which affects its insulating properties. It must, therefore, be systematically inspected and tested. When its dielectric strength tests below the value prescribed by the manufacturer of the equipment, the oil must be purified to prevent failure from burnouts and consequent interruption of service.

Suitable filters or centrifugal separators are essential to the satisfactory performance of transformers, as well as other insulators. The deleterious effect of small amounts of moisture on the dielectric strength of oil is even more serious than is generally supposed. The curve in Fig. 7 shows clearly the great reduction in dielectric strength produced by the presence of water in amounts up to eight parts in 100,000. After apparatus has been in service for some time it is possible for its factor of safety to be reduced 30 to 50 per cent by moisture entering the oil.

The transformer, filter press with pump and piping should be so arranged and valved as to permit the following operations without interruption to service.

(a) Drawing sample of oil from any transformer or tank for testing. Most transformers are equipped with sampling cock for this.

(b) Filtering and circulating oil through piping system to remove moisture and sediment before the main filtering operation is started.

(c) Filtering the oil in any one transformer—storage—or drain tank.

(d) Filtering from drain tank to storage tank, from

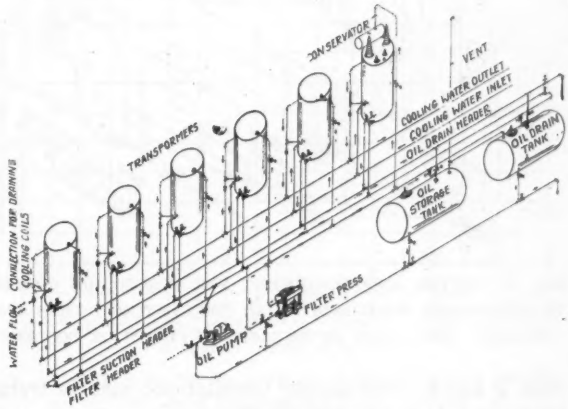


FIG. 4. PIPING AND EQUIPMENT FOR OIL-FILLED WATER COOLED TRANSFORMER INSTALLATION

either of these to transformers or from barrels to any tank or transformer.

The apparatus necessary to determine the condition of the oil and for filtering during operation or repairs is as follows:

Oil testing set, oil filter press with pump, filter drying oven, filter suction header with connections, filter discharge header with connections, and storage tank.

The oil testing set consists essentially of a step-up transformer and a spark gap, and is manufactured in convenient portable units. The dielectric condition of transformer oil is determined by testing the strength of a sample in the spark gap according to instructions for the particular testing set used. In new installations the oil in each transformer should be tested at least every week for the first month, or until the rate of defection is reasonably well established for the particular locality and apparatus. The period may then be increased as found expedient, but should not be extended beyond three months for any one water cooled transformer, or six months for self-cooled.

Samples for tests should be drawn from the bottom layers where moisture and other impurities are most likely to be present in the oil. This is particularly true

in transformers which have been allowed to stand idle for some time. A sample taken from such a transformer some distance above the bottom may, and generally will, indicate a greater dielectric strength than would be the case if the sample were taken with the transformer under load and the oil in circulation.

Filter presses made of ordinary blotting paper clamped between metal frames have proven as satisfactory for maintaining the dielectric strength of oil as any other commercial type. Any moisture in the oil is extracted by capillary action. Solid matter is caught by the paper. Passing the oil once through such a filter is generally sufficient to produce as high dielectric strength as practically desirable with the oil in regular use.

In a relatively large installation the filter should be connected to a permanent piping system as indicated in

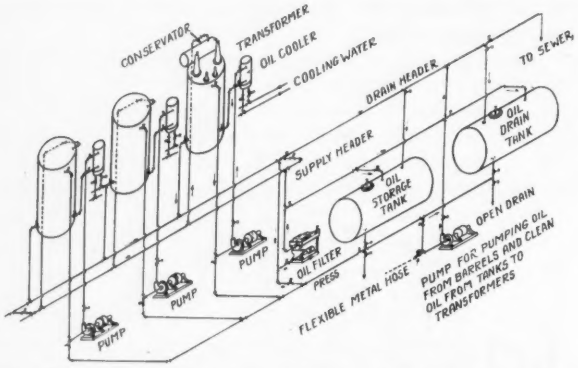


FIG. 5. PIPING AND EQUIPMENT FOR FORCED OIL COOLED TRANSFORMERS WITH INDIVIDUAL CIRCULATING PUMPS AND COOLERS. NO SPARE OR EMERGENCY PUMPS OR COOLERS

Figs. 2 and 4. For smaller installations, such as transformer substations where the filtering operation is only occasional, it is of advantage to have a portable filter as indicated in Fig. 1, equipped with flexible metal hose for temporary connection to the transformer whose oil is to be filtered. Rubber hose should not be used since oil and rubber detrimentally affect one another.

In order to avoid reaeration of the oil in conservator type transformers during the operation of filtering, modern filter presses are equipped with an air bell and necessary valves for testing piping for leaks before filtering of the main body of oil is begun. Without such a device, leaks in the suction piping are difficult to locate as they are inward and do not show on the surface of the pipe. The air bell is inserted in the pump discharge and provides a means for applying a pressure of 20 lb. per sq. in. to the suction piping, by utilizing the pump on the press for creating the pressure. The pipes are allowed to stand under pressure for as long a period of time as practical and leaks around joints are noted. Inasmuch as the pressure in this case is outward, the oil will leak out and indicate any joint which is not tight. By making the joints in the intake piping tight and observing the simple precaution of forcing all of the air out of the press, after the paper has been changed, it is possible entirely to prevent reaeration of the oil.

The use of filtering equipment which again thoroughly mixes air with the oil being filtered partially defeats the purpose of a conservator in that its particular advantage is the protection of oil from the air. The air which is originally dissolved in the oil is gradually dissipated during the initial operation of the transformer; to filter the oil and again reaerate it brings the oxygen content of the oil up to normal, which is undesirable.

Electrically heated drying ovens are available for drying filter papers before use in the filter press. It is essential to the purification of the oil that the papers be thoroughly dried, not merely air dried, at room temperature but slowly dried for at least 24 hr. in heated ovens starting with a temperature of 35 deg. C. and ending with about 80 to 85 deg. C. Immediately upon removal from the oven the papers should be saturated with purified oil, or placed in the filter press to avoid absorption of moisture from the air as far as it is possible to do so.

Suction and discharge headers should be provided and connected to transformers, filters and tanks, so that any desired operation may be accomplished simply by proper manipulation of valves. The headers need be no larger than the inlet and outlet of the filter set for the suction and discharge headers respectively. Avoid pockets by grading slightly towards the filter. The two headers must be connected at the ends through valves to form a complete loop through which oil may be circulated for cleaning as before mentioned.

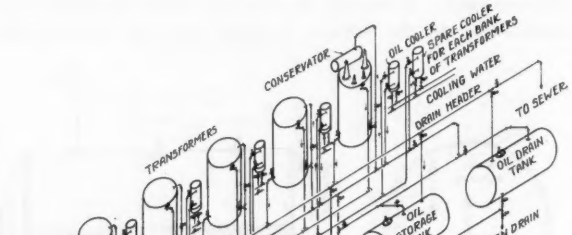


FIG. 6. PIPING AND EQUIPMENT FOR FORCED OIL COOLED TRANSFORMERS WITH INDIVIDUAL COOLERS, ONE COMMON CIRCULATING PUMP PER BANK, ONE SPARE OR EMERGENCY COOLER AND PUMP

It is sometimes necessary to remove oil from transformers for repairs or inspection. A storage tank of sufficient capacity to hold somewhat more than the largest transformer tank in the station should therefore be provided. The extra capacity is used for storing oil required to make up for evaporation, slight leaks, samples for test and other losses incidental to the handling of oil. Inspection or repairs and filtering may then be carried on simultaneously and the transformer quickly restored to service when finished.

The storage tank, like the drain tank, must be provided with an outlet at the lowest point so that it can be drained of sludge, sediment or moisture. A manhole is necessary for inspection and thorough cleaning or scraping of the inside surfaces of the tank. A small vent should be extended to a level slightly above the

highest oil level of the transformers to permit oil flowing into the tank, but prevent overflowing. If desired, a float valve may be substituted for the long vent pipe. which, however, is simpler and more reliable. Figure 3 shows a tank properly equipped with extended inlet. vent, manhole, drain and gage glasses.

Quick Filling

Reliability of service demands provision for quick filling of transformers once they are returned to their regular location and connected to the line. The capacity of the filter press pump may be insufficient to accomplish this in less than several hours. A separate pump should then be provided, of such capacity that the largest transformer can be filled in about half an hour. The pump should be connected so that transformers may be filled from barrels, from storage tank, or from drain tank as shown in Figs. 2 and 4. The headers used for filter suction may be used for this purpose. Use clean oil only, and fill from bottom of tank. The sizes of pipes must be checked with the capacity and head of the separate pump to make sure that oil will flow with the velocity required for the quick filling operation with only reasonable loss of pressure head. This friction loss must be added to the maximum static head (maximum vertical distance between levels of oil in the supply tank and the transformers) to obtain the total or dynamic head against which the pump should be designed to handle normal capacity. It is well to add at least 25 per cent to the estimated total head to make up for velocity head losses at inlets and outlets as well as for variations in viscosity.

Positive pressure, or displacement, pumps are not seriously affected as to capacity by changes in viscosity and are therefore preferable to centrifugal pumps, but must, for satisfactory operation, be equipped with relief valve and bypass connection.

Storing Oil

As previously mentioned, a certain amount of oil must be stored on the premises to make up for losses from evaporation, draining of sludge and sediment, etc. The proper amount for any one installation can be determined only by experience with the particular installation. An amount equal to about 10 per cent of the oil in the largest transformer should be stored in the storage tank.

Any additional storage found to be of advantage should be in barrels, stored in separate fireproof vaults held at uniform temperature.

Circulation of Oil for "Forced Oil" Transformers

Careless operators will sometimes improperly drain the water from the cooling coils of water-cooled transformers temporarily cut out of service. If the remaining water freezes, the coils may develop leaks which permit water to mix with the oil, thereby seriously affecting its insulating properties, as well as wetting the transformer coils and causing failure.

"Forced oil" type of transformers which have been developed using external coolers eliminate this hazard. The oil in this case is circulated through coils in separate water-cooled tanks. To prevent water entering the oil space, the oil is circulated under pressure somewhat in excess of the prevailing water pressure in the tank. The amount of oil per kilowatt rating of transformer is generally less than for any other type so that smaller tanks may be used for the transformers.

This method of cooling is extensively used in European countries, but does not seem to have met with much favor in this country, presumably on account of the infrequent mechanical breakdowns of the internal cooling coils in water-cooled transformers and the fact that the use of separate coolers carries no positive insurance against water in the oil space, due to careless operations, in spite of the greater oil pressure; however, a few such installations are in successful operation in this country.

Continuous equalized circulation of oil is essential to transformers of this type. The safest means of obtaining it is by individual coolers and pumps for each transformer as indicated by Fig. 5. This method has the disadvantage, however, of tying up the operation of

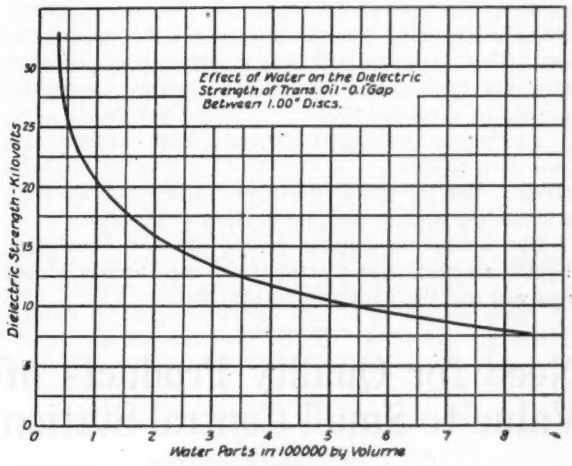


FIG. 7. CURVE SHOWING EFFECT OF MOISTURE ON DIELECTRIC STRENGTH OF OIL

a transformer with that of several inherently less reliable apparatus, such as the pump and motor. A spare cooler and pump should therefore be provided as shown in Fig. 6, but must in order to serve its purpose be connected to headers serving all other coolers and pumps. Connections must be so valved that the spare unit can conveniently be substituted for any other unit simply by valve manipulation.

Piping Specifications

Standard weight, open hearth, steel pipe may ordinarily be used for all connections. It should be perfectly straight and smooth and rigidly supported to preclude formation of pockets. Threads must be cut with clean, sharp dies, and burs carefully reamed out. Chips, filings, scales and other impurities must be entirely removed from the inner surfaces of pipes before installation.

Fittings must be of extra heavy weight, in sizes smaller than 1 in., of brass, screwed; in larger sizes of cast iron, screwed, free from blow holes and other imperfections. Threads must be clean, sharp and smooth.

All valves not furnished with transformers, pumps or filters must be globe pattern or disc valves of extra heavy weight with clean, sharp and smooth threads and renewable discs with outside screw. Brass valves should

be used in sizes 2½ in. and smaller. For 3 in. and larger, cast-iron body with bronze mounting.

Unions in sizes smaller than 1 in. should be all brass, sizes 1 in. to 2½ in., inclusive, brass seated malleable iron.

In sizes 3 in. and larger, use extra heavy cast-iron flanges, free from blow holes and other imperfections. Threads must be clean, sharp and smooth.

Gaskets must be of fibre, asbestos or cork compositions treated with moisture-proof compound such as bakelite varnish before installation. Gaskets of metal or rubber compounds are not acceptable.

Joints must be carefully made to hold tight for hot mineral oil. Oil-tight welded joints are preferred, but where welding is impracticable, pipe joint compounds may be used. One very good pipe joint compound of proven reliability is made of gum shellac or commercial prepared shellac cut with wood alcohol to a syrupy substance. One part of this syrup is thoroughly mixed with pine tar and the mixture boiled slowly for one hour. This compound will keep indefinitely. It is necessary only to thin it with ordinary commercial shellac varnish to give the proper working thickness.

Another exceedingly good pipe joint compound is made of a solution of a synthetic resin in an alcoholic solvent. The solvent soon evaporates, leaving the resin in a viscous, sticky condition in the sealed joints.

For temporary piping joints, ordinary bar soap slightly moistened and scraped on the threads of the pipe will seal the joint surprisingly well.

Need for Quality Products of Value to Small Central Station

By L. W. Alwyn-Schmidt

INCREASED PRODUCTION in many branches of manufacture, coupled with a steady increase in the number of domestic users of electricity, has brought about a continual increase in power demand from the central stations. To meet this demand the central stations have turned all their efforts to developing methods for the economical generation of power.

There has been a distinct tendency lately, however, on the part of the public to demand quality goods, at a price which makes necessary more attention to the elimination of waste in industry, and it is with these last two aspects of the economic situation that the central station owners are concerned as well as with the generation of power.

As matters stand today in the power industry, much of the pioneer work is done by the commercial staff of the central station. It is the sales manager or the salesmen who are first faced by any sort of change in the purchasing tendencies of the market.

Since these changes develop, as a rule, gradually, there has been plenty of time in the past for the engineering staff to catch up with the demands of the sales organization; but it is doubtful whether the central station, to do its work well, will be permitted to carry on the present system of division of labor. To make the work of the station effective and useful for the consumer, it will be necessary to employ more modern methods of power sales. We shall not merely sell power to the consumer but also the *use of power*. The field representative of the power station will have to be an engineer-salesman, and, to make the team complete, the central station man will have to acquire a close intimacy with the problems of his market. He will have to control not only the production and distribution of power but he must also know the condition under which it is used by the consumer.

Much has been done in the last few years to increase the utilization of electrical power in the home. This has been effected by the sale of electrical equipment for use in the home, as washing machines and other domestic conveniences. By this means there already has been obtained a better distribution of the daily load. But the new requirements of the industrial consumer exceed those of the home. There can not be merely a selling of industrial equipment. There must be a real service with a complete understanding of the problems of his industry. Electrical power can not for him be only an added convenience. It must become a vital aid in the solution of his great problem of keeping up with the progress and demands of industrial competition.

This duty of giving increased development service falls most heavy upon the central station serving the small electrical industrial consumer, located away from the large industrial center. The big industrial undertaking and the manufacturer located in a highly developed industrial district find it easy as a rule to obtain the advice and counsel which he requires. Comparison alone serves as a competent instructor for the business man who has eyes to see. Such means, however, are out of reach of the small town producer. For him the central station must do the work which otherwise he must have done by the aid of trained experts. And it is the small town industrial producer who will need such help most because it is he most likely who will feel the impact of the new economic wave.

There was a time in the industrial history of the world where the small town industrial producer was actually favored in his competition with the large industrial plants. Knowing his market better than the big producer from outside, he found it easy to compete and the then existing methods of industrial production gave him at least an equal chance. Today quantity production has led to a complete shift in favor of the big producer. Now the swing back to quality production will return to him his opportunity. But he will not be able to grasp it unless he finds himself fully supported by his local central station. It is the central station which must show him how to use his new chances. It is the central station which has to supply the required technical knowledge, and it is the central station which must provide the required power.

Here, therefore, is a splendid opening for the central station, both to do a real service to its consumers and to increase its own income by adding to its load.

A far-reaching change in the character of a whole market does not come over night. It's not a revolutionary movement which takes place today, but rather a steady evolution in the direction of new industrial standards. There is no reason, therefore, to expect a sudden flurry. We are not at the beginning of a sensational boom, but we are in the early stages of a systematic change in the industrial make-up of our nation, which is the more sure to reach completion as it is the natural

outcome of a re-orientation in the labor situation. It also conforms much better to the general tendencies of American business which has always favored the quality product.

While, therefore, there is no need for making far-reaching changes in the sales and distribution policy of small-town central stations, there is on the other hand every cause to lay one's plans accordingly.

These plans should include:

(1) A survey of the industrial conditions of the present market and its likely development under the newly-appearing conditions.

(2) A study of ways and means likely to aid the district in falling in step with the industrial demands of the situation.

(3) The organization of a sales and engineering staff, able to handle successfully this situation.

The small town in recent years has shown remarkable reserves of industrial strength. Giving as a whole better living conditions, it has been comparatively free of labor troubles. Rents being lower and plenty of space available the formation of small industrial units has been favored in such localities. Railroad rates have favored the growth of small town distribution centers with an ever-widening radius of action. Now the swing to quality production based upon a general improvement of industrial equipment will give the small town an equal standing with the big producer.

Electric Power Makes Progress

RECENTLY an Electrical Week was staged by the Cleveland (Ohio) Chamber of Commerce including as features, window displays, newspaper articles and, as a climax, a luncheon meeting at which electrical products of Cleveland were exhibited, while thirty civic and business organizations joined in listening to a review of the city's electrical features and of the progress of electric power.

Census of its industries showed that 135 manufacturers of electrical products in Cleveland use $75,000,000 of capital, employ 35,000 workers and turn out 250 different products with an annual value of $130,000,000.

At the luncheon, Charles F. Brush, inventor of the arc lamp, was introduced, also officials of the railway and the telephone companies.

J. F. Lincoln, vice-president and general manager of the Lincoln Electric Co., reviewed the electrical products of Cleveland which meet the daily needs of the average citizen in his home, his traveling and his work, showing that life and industry, without this modern equipment, would be impossible in our great cities.

M. H. Aylesworth spoke of the first street lighting and first going electric street railway as part of Cleveland's electrical history. He then gave striking illustrations of the rapid growth of electric power and light. Today $7,500,000,000 are invested in the light and power companies of the United States, securities being owned by over 1,500,000 people. All progress in methods and equipment have been through private enterprise. Public utility power equipment has jumped from 3,000,000 hp. in 1900 to 30,500,000 hp. at present. Interconnection of systems and interchange of power have developed over wide areas; on the Pacific Coast, from Canada to Mexico; in the central region, from Pennsylvania to Wisconsin; in the southeast, from Virginia to Florida.

Of water power, we have some 20,000,000 hp. available half the time and 35,000,000 hp. available 90 per cent of the time but not all of it is developed and, while 72 per cent of it is west of the Mississippi River, 79 per cent of the power demand is east of that river.

So, since we are using 50,000,000 hp. of prime movers today, it is obvious that, for most of our power we must rely on steam plants.

Mine-mouth power plants are not often feasible since for each pound of coal burned, 600 lb. of water must be available for condensing purposes and such amounts of water are not usual near coal mines.

In the United States are now 26,500,000 homes, about half of which are wired for electricity. This leaves great opportunity remaining for growth of the industry.

Only 44 yr. ago Thomas Edison sent all the incandescent lamps there were in the world to New York in a market basket. Last year the country's output was 450,000,000 bulbs, four to each resident. Kilowatt-hours output of utilities was 2½ billion in 1902; last year it was 60 billion and this year will be many billion more.

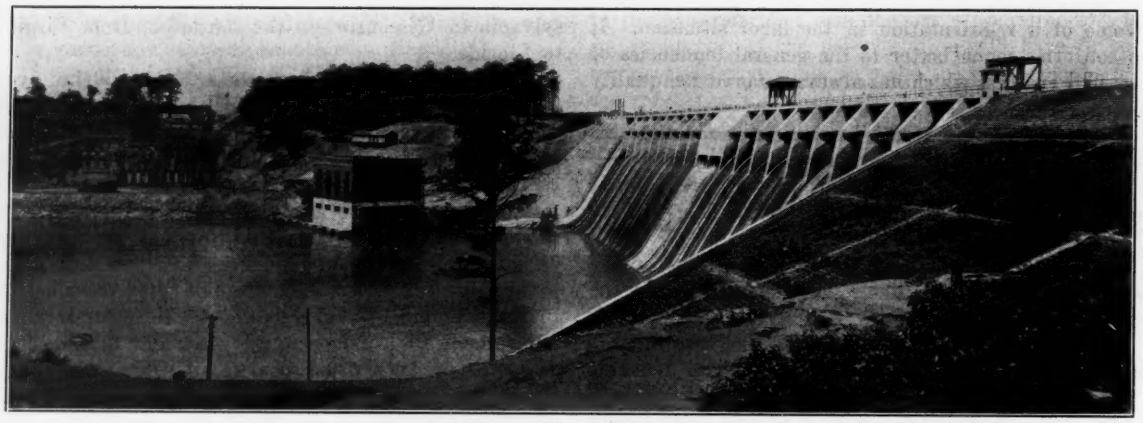
The Christmas Spirit

HAS the old Christmas gone? Have our modern customs, our material standard of gifts, the idea of even exchange of values buried the simple good fellowship of this holiday season? Is "Peace on Earth, Good Will toward Men" now but an empty phrase?

In the olden times, the joining of all in the celebration of Christ's birthday, was a simple, heartfelt festival, with holly, mistletoe, the yule log, common dancing, open hospitality and friendship. Merriment, thankfulness and helpfulness to others were the foundations of the joyful season. Carolers in groups of three sang greetings to the people, the old time songs, which still carry the old time spirit of Christmas and warm our hearts to kindlier living.

It is in memory of that custom that the 1926 Christmas seal shows the carolers, a symbol of the spirit which unites all people of all lands in simple service and good wishes to others. At the same time, the seals serve as messengers of health for they help provide funds for the work of the National Tuberculosis Association and its affiliated state and local organizations which are carrying on the work of stamping out that dread enemy of mankind.

So long as such work is carried on to rid the world of sickness and unhappiness, the old Christmas spirit is not gone and we may well participate by buying and using these seals, so furthering this service to humanity and spreading the spirit of fellowship and good cheer.



Bartlett's Ferry Begins Operation with Two Units

NEW HYDRO-ELECTRIC PROJECT DESIGNED FOR ULTIMATE CAPACITY OF 60,000 KW. IN FOUR UNITS, WITH A POSSIBLE FIFTH, SERVES SYSTEM OF COLUMBUS (GA.) ELECTRIC & POWER CO.

BARTLETT'S Ferry Dam on the Chattahoochee River, about 20 mi. north of Columbus, Ga., was put into service this year by the Columbus Electric and Power Co. This company owns and operates several other hydro-electric stations on this river and serves a territory in Alabama and Georgia southwest from Atlanta, the system centering at Columbus, Ga. At Bartlett's Ferry the Chattahoochee River has a drainage area of about 4200 sq. mi. A discharge of 2000 c.f.s. is available 90 per cent of the time, but there are occasional periods of extended drought.

The plant is designed for an effective head of about 112 ft., determined by the elevation of the Goat Rock pond 6 mi. below and the tailwater of a plant at Riverview, 10 mi. upstream. An effective storage capacity of 120,000 acre-feet is provided. The Bartlett's Ferry development was designed for an ultimate capacity of 60,000 kw. in four units, of which two are at present installed. Provision has been made for a possible extension to 75,000 by designing certain structures so as not actually to prohibit the addition of a fifth generating unit. The project was planned as a storage and power development and seems the logical point to develop peak capacity for the system.

In the head piece is shown a general view of the dam and power house at Bartlett's Ferry. After a careful study, it was decided to utilize the full width of the river for spillway purposes, so that the power house was located on the west bank where foundation conditions were favorable. A solid gravity type overflow spillway, with earth embankments was the type adopted. The dam has a maximum height above bed rock of 145 ft. and a total length over all of 1975 ft. Of this 634 ft. is concrete spillway, 92 ft. is concrete intake structure and the remainder earth embankment.

Regulating structures on the crest of the dam include 19 tainter gates, two skimmer gates and a battery of four siphon spillways. The tainter gates are of structural steel, each 25 ft. long and 21 ft. high, raised and lowered by two entirely housed traveling gantry cranes. These gates furnish flood capacity. Skimmer gates for manual regulation are of the sliding drop type, each gate having an individual motor-driven double screw hoist. The siphon section consists of four units each with a throat four feet high and 11 ft. 3 in. long. The crest of the first section is at an elevation of 520 and the crests of the others at elevations one, two and three inches respectively above this. The units are designed to prime successively as the water rises and to break successively as it falls. Through the base of the dam are four sluiceways each closed by a 4 by 4-ft. Coffin gate. These sluiceways aid in regulation. An inspection gallery runs through the spillway section. Transverse expansion joints are located about 87 ft. apart on the length of the spillway section. The earth dikes are of native red clay and many interesting problems arose in their construction.

On the west bank of the river, the reinforced concrete intake structure is located on a block of mass concrete supported on a solid rock foundation. The intake has four bays, with 15 by 20-ft. sliding head gates of structural steel, weighted with concrete and actuated by motor-driven double screw hoists. These drives have gear shifts to increase the power and decrease the speed for operation if a gate should stick. Trash racks in 12 separate sections for each bay, operate in vertical guides. Mechanically operated rakes may be installed later.

Supplying each of the initial units is a steel penstock 14 ft. in diameter and 300 ft. long. These are made of steel plate with stiffener angles, and saddles designed to resist the distorting effects of filling and emptying the penstocks.

As shown in the head piece, the power house is on the west bank. It is 90 by 80 ft. of steel and brick construction on a reinforced concrete substructure. It has three levels; drain valve pits and drain gallery on the lowest, turbine deck next and generator floor at elevation 533. The generator floor is designed to support a railroad track and a movable load equal to the largest outdoor transformer. This floor is divided longitudinally into generator room and electrical bay. The west end of the building has a temporary wall, which can be easily removed if extensions are made.

Water wheels, governors, oiling system and accessories were furnished by S. Morgan Smith Co. Wheels are of the single runner, vertical Francis type, with

riveted scroll cases. Each wheel is rated at 22,000 hp. at 112 ft. head. Synchronous speed of the units is 150 r.p.m. and specific speed 61. Each wheel has one babbited steady bearing designed for oil lubrication. The draft tube is of the modified elbow type, flattened at the turn with the draft tube seal submerged 7 ft. below minimum tail water level. Water wheel governors are of 120,000 ft. lb. capacity, at an oil pressure of 175 lb. The governor oil system is laid out on the unit plan with one governor, pressure tank, sump tank and oil pump cross-connected for substitution or for a future unit. Governor oil and lubricating oil systems for both water-wheel and generator are connected and the same oil is used throughout so that the lubricating system may be filled from the governor system. Quimby oil pumps are used, together with filters.

Westinghouse vertical a. c. generators are driven by the water wheels. Figure 2 shows the two units installed at present. These are rated at 18,750 kv.a. each, at 0.8 p.f., 12,000 v., 3 phase, 60 cycles, 150 r.p.m. Each generator has a Kingsbury thrust bearing, running in an oil bath and also water cooled, and two guide bearings. A direct connected 125-kw. exciter is mounted above the thrust bearing on each unit and a spare motor-driven exciter is provided.

Generator neutrals are solidly grounded through a neutral bus. Differential relay protection is provided. The generators are cooled by drawing air from the generator room and discharging it through the generator pit and openings in the outside wall immediately above the tailrace.

Located in a room which has a bay window overlooking the generator room is the control switchboard. This is a benchboard of four panels on which are mounted the instruments and the control for the generators, exciters and 12-kv. and 110-kv. feeders. The relay and metering equipment is mounted on a vertical board directly behind the benchboard.

The station service switchboard is located in a room immediately below the control room, but the important station service circuits are remote-controlled from the main control room. A single 12,000-v. generator bus is provided for the switching of the generator and station service power and there is a single excitation bus for switching the spare exciter.

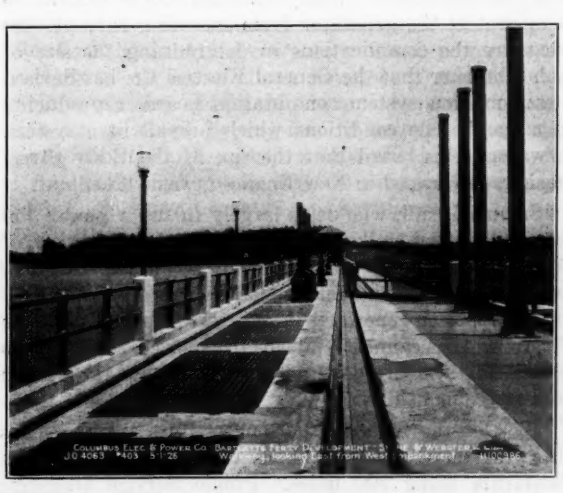


FIG. 1. WALKWAY ACROSS TOP OF DAM LOOKING EAST

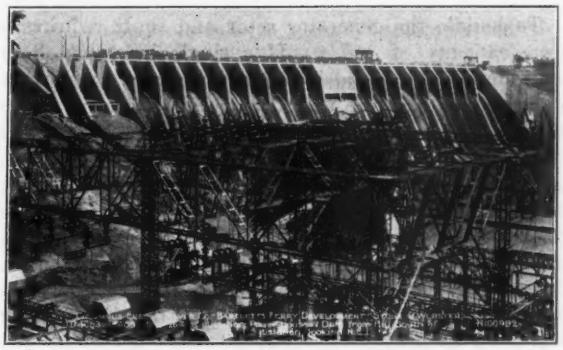


FIG. 3. OUTDOOR SUBSTATION HAS POWER TRANSFORMERS ON LOWER TERRACE, CIRCUIT BREAKERS ON THE INTERMEDIATE AND LIGHTNING ARRESTERS ON UPPER TERRACE

The generator bus is located at the generator floor level with the main circuit breakers on the floor directly above. These breakers are solenoid-operated with a normal rating of 1600 amp. and a rupturing capacity of 24,000 amp. at 12,000 v.

Station service power is obtained at 575 v. from two transformer banks each consisting of three single-phase transformers. Station auxiliaries are controlled by double throw switches adjacent to the motors, the motors having two distinct sources of power from the station service switchboard. Motor-driven auxiliaries at the dam also have two sources of power distributed through a service room at the intake. The control battery has a normal rating of 40 amp. at 125 v. Two motor-driven charging sets are located adjacent to the battery.

Station lighting is obtained from a 50-kv.a. transformer rated 575 to 220/110 v. Emergency lighting is obtained by automatic switching from the lighting transformer to the 125-v. control battery.

Provision is made for electrically heating the electrical bay. For heating the generator room provision is made for recirculation of the air from the generators.

From the electrical bay to the substation there will be two power feeders carried overhead on steel supports. The conductors are 750,000 circular mils bare stranded copper cable.

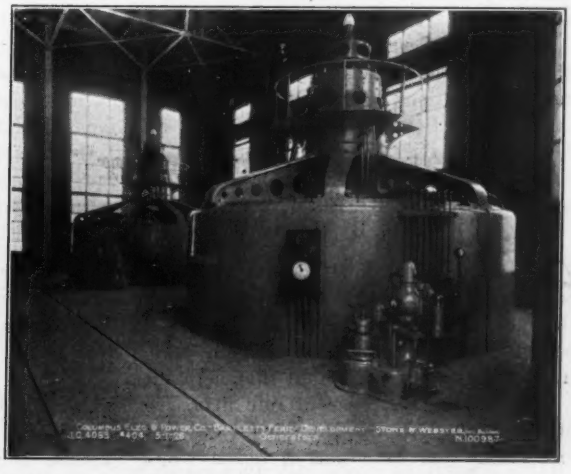


FIG. 2. PRESENT INSTALLATION CONSISTS OF THESE TWO 15,000-KW. UNITS

To handle the generator rotor and shaft requires a crane capacity of 110 t. If a single hoist had been used, however, it would have been necessary to increase the height of building in order to have sufficient clearance to lift the rotor and shaft over the top of the stator ring. To avoid this a double hoist was adopted, with twin hooks, which engage the ends of a lifting beam. This beam is designed to slip down over the generator shaft and bears against a split ring key which is bolted on the shaft after the lifting beam is in place. This arrangement permits the hooks to be brought down a considerable distance below the top of the shaft which is allowed to project upwards between the bridge girders of the crane.

Substation

The outdoor substation is located about 300 ft. from the generating station. It consists of an open steel structure of three bays, and contains the power transformers, 110,000-v. oil circuit breakers, lightning arresters, and instrument transformers.

Each of the two 12,000-v. power circuits is connected directly to a bank of three single-phase transformers Y connected, which step the voltage up to 110,000 v. These transformers were manufactured by the Westinghouse Electric & Mfg. Co., and are water-cooled. One spare transformer is kept on a transfer truck on the transfer track at the substation.

From the transformer bank, the 110,000-v. circuit is connected through oil circuit breakers to a single bus. Three 110,000-v. feeders are connected to the 110,000-v. bus by means of oil circuit breakers, which are shunted by pole top switches.

The 110,000-v. oil circuit breakers are the Westinghouse type G-222. They are solenoid-operated, normally rated at 400 amp. and have a rupturing capacity of 7650 amp. to 115,000 v. They are remote-controlled from the main switchboard in the generating station.

In the building of Bartlett's Ferry dam, two railroad bridges, five highway bridges, 2¾ mi. of railroad and 2½ mi. of highway had to be relocated and rebuilt. A large and completely equipped construction plant was necessary and a great deal of work had to be done in clearing the flooded area to satisfy the requirements of the Federal Power Commission and the State Boards of Health.

Bartlett's Ferry project was designed and built by Stone & Webster, Inc., with Charles T. Main as consulting engineer.

What Is Super Power?*

Its Limitations and Its Possibilities. By Henry W. Ballou**

GETTING right down to brass tacks,—what can super power do to us? The answer is that it may vary the cost of electric power and light. But how much will that affect industries? If you *gave* power to our industries, how much would that help them?

In 20-yr. experience of our firm, serving over 700 clients located in the southern New England states, I can recall less than half a dozen whose expense for power and light was over five per cent of gross receipts. The great majority spend less than three per cent, yet no industry denies itself power although some are niggardly with light. Commitments in raw materials will, in some industries, fluctuate more in value in a single week than the entire annual cost of power and light. Super power will neither make nor break industries because any conceivable effect on the cost of power would be a negligible factor in the total budget of expenses.

The expression "super power" is said to have originated with the late Franklin K. Lane during Wilson's administration but is now generally associated with the name of W. S. Murray of New York. In 1919 transactions of the A. I. E. E., Mr. Murray says: "Super power contemplates a trunk line transmission between Boston and Washington, the route of which would be sufficiently removed from the coast as a military precaution. It would tie together all of the power stations, steam and hydraulic." In his book, published in 1925, Mr. Murray says: "Super power is, in reality, merely a better power supply than is now available, and its three cardinal principles are: Power more adequately generated; more reliably generated and distributed; generated at lower cost." (In other places, Mr. Murray has advanced the thought that power should be given the greatest availability to the greatest possible number of users.)

Philip Torchio, chief engineer of the New York Edison Co., in transactions of the A. I. E. E., 1919 says: "Inter-company ties will secure all the advantages that Mr. Murray points out and will give a more reliable service than if we tried to supply power over long distance transmission lines."

In brief, super power seems to me to mean interconnection of many widely separated power plants. A recent map shows the transmission lines of the Northeastern Power Association, reaching from Boston to Detroit and from Hamilton, Can., to some town in Maryland, a system over a thousand miles in length. The switching and transformer station, of outdoor type, which connects the Narragansett Electric Lighting Co.'s plant to this system has an investment of a quarter million dollars and the 35,000-kw. generator at Eddy Street is equipped with a main circuit breaker to interrupt the current that could be produced by all of the generators in all of the power plants connected to the system, so as to protect the generator from incoming current. So great are the complications in determining the size of such a breaker that the General Electric Co. has devised a transmission system computation board, reproducing on a small scale conditions which prevail in a system. It was on this board that the size of the Eddy Street breaker, the largest in New England, was worked out.

Samuel Insull, who deals largely in super power and acts rather than talks, said to the Boston Chamber of Commerce recently that although he has a 730-mile transmission system, that does not mean economical delivery of power generated in Wisconsin to coal mines in Virginia. He cannot send electric power from end to end of his system—does not even say how far he can send it economically.

East of the Rockies, the longest lines are 175 miles but west there are eight lines over 200 miles, one in California being 500 miles. Public Service Magazine of Chicago states that: "The longest distance which electricity can be transmitted over wires and compare

*From an address to the Lions Club.
**Jenks & Ballou, Providence, R. I.

favorably with local power in economy is 250 miles. Cost of generating electricity is only about 20 per cent of the total bill."

As a test problem, our office calculated whether, with coal at no cost in Boston, it would pay to generate electricity in Boston and transmit to New York, 230 miles, rather than buy coal in New York and generate the current there. The answer, checked by transmission experts of the General Electric Co. at Schenectady, was that it would be cheaper to buy coal and generate in New York.

Governor Pinchot of Pennsylvania has talked much about "Giant Power." The difference between that and super power seems to be that the Government would own the interconnecting transmission systems and all power plants would be compelled to connect to these lines, which Mr. Pinchot says, would "pool" all sources of electric power. So far as pool involves the idea of storage, this is an abuse of its meaning, for there can be no storage of electric power.

Mr. Pinchot also thinks that great savings would be effected by generating current at the coal mines. This is no new idea. In Pittsburgh, two big plants, Springdale and Colfax, are right over the mines which serve them and it happens that the condensing water, which is as indispensable as the coal, is available there. For every ton of coal burned, 400 to 600 t. of condensing water are needed and such quantities of water are available at but few mines.

Saving in freight charges on coal is a principal element in Governor Pinchot's pet scheme but transmission lines for electric current are expensive things, too. A recent estimate for a line from Boston to Rhode Island was $55,000 a mile, or a 250-mile line would cost $12,500,000, and such a line would have transmitting capacity considerably less than that of a generating plant which would cost half the amount. So, even with plenty of water available, it would be cheaper to ship the coal and generate power locally than to generate at the mines and transmit current, when a distance of 250 miles or more is to be considered.

It is well to remember that the investment of public utilities is mostly outside the power plant. In Providence, only one-third the investment is for the plant; the rest for distribution. Strange as it may seem one-quarter of the current used in Buffalo, N. Y., only 22 miles from Niagara, is generated in steam power plants.

Hydro-electric power can never be a major factor. At present, east of the Mississippi River about one-third the power is hydro, the balance steam. Muscle Shoals, about which such a windy war has raged, can be depended on for only 100,000 primary horsepower and investment cost is $490 per horsepower. The Narragansett plant in Providence has twice that capacity and costs only one-quarter as much per horsepower. Furthermore, coal consumption has been reduced in 27 yr. from 4 lb. of coal per kilowatt-hour to 1 lb., while improvement in performance of water-wheels has been only one-eighth as great.

To summarize, life of industries is not dependent on super power because: Power cost is a minor item in budgets; anybody can buy coal and make his own power; electric power cannot be transmitted economically far from water power sites or coal mines; hydro-electric power will always be subordinate to steam power; interconnection is already accomplished to a large degree, yet local plants are found to be cheaper to operate than long distance transmission.

Secretary Hoover Urges Reduction of Wastes

ELIMINATION of waste is the keynote again sounded by the Secretary of Commerce in his annual report which has just been issued. Among the agencies, the report indicates, through which major wastes may be eliminated are super power steam-electric and hydro-electric plants.

Speaking of savings accomplished by the establishment of large central power stations through which large industrial systems are fed, the report says: "Such savings lay in the greater economy in power production by saving fuel and labor by the larger central plants; the reduction of the amount of reserve equipment required; a better average load factor, and thus less equipment, through pooling of the daily and seasonal fluctuations, together with wider diversification in use; more security against interruption; better utilization of water power by applying it to base loads while making steam carry the peaks; utilization of secondary power from the seasonal flow of streams to the partial relief of steam; savings in industry by replacement of factory steam plants, the increased day load being supplied by the same generation equipment as night load for cities; the larger application of power in replacement of factory labor; and likewise the economies in the household and farm application of power.

"All of these anticipated values have been realized in an extraordinary degree through the initiative and genius displayed in the electrical industry. The electrical generating capacity in the country has increased from 14,280,000 to 23,840,000 kw. in 5 yr., an increase of 67 per cent. Although 66 per cent of our energy output is from fuel the development of water power has been most active. Of the total of 8,300,000 water horsepower now developed and connected into the systems, 2,500,000 hp., or some 43 per cent, has been set to work in the last 5 yr. The enormous savings that have been made in fuel consumption are indicated by the fact that while the electrical output of fuel-burning central stations increased 67 per cent in 5 yr., the fuel used increased less than 15 per cent. The average consumption of coal or its equivalent by such central electrical generation plants decreased from 3 lb. per kilowatt-hour in 1920 to 2.1 lb. during 1925, a saving at the average rate of 11,500,000 t. a year; new water power effected a further annual saving equivalent to 3,100,000 t.

"There has been a large increase in the application of electrical power in manufacturing and while there has been an increase during this period of between five and six million horsepower used in factory production, there has been no increase in boilers and engines installed within these plants, the increase having been made almost entirely by electrical motors operated through purchased power. There has also been a transformation from direct-connected steam equipment within factories to factory electrical generation for distribution throughout the plants until at the present moment

apparently 70 per cent of factory power is delivered to the machines electrically.

"This transformation, it may be said at once, has increased the productivity of our workmen beyond those of any other country; it contributes to our maintenance of high real wages and to the reduction of human sweat

"There is still further promise of great progress in the reduction of fuel consumption in the extension of electrification, particularly in the further replacement of factory steam plants, in the electrification of our large railway terminals and the expansion of household use of power.

"Water is today our greatest undeveloped resource. Our streams and rivers offer us a possible total of 55,000,000 hp., and of this less than 11,000,000 hp. have been developed. Of our 25,000 mi. of possible inland waterways probably less than 7000 are really modernized, and the utility of much of these 7000 mi. is minimized by their isolation into segments of what should be connected transportation systems.

"There are imperative reasons for the execution of a comprehensive plan for the co-ordinated long-view development of each river system to its maximum utilization. The necessary advances in rail rates from the war, together with completion of the Panama Canal, have distorted the economic relationship of mid-west agriculture and mid-west industry to the rest of the country and to the world markets. This relationship can be restored by conversion of our inland waterways into real connected transportation systems for cheaper movement of bulk commodities and raw materials. There will be increasing demand for hydro-electric power with its saving of fuel and reduction in human sweat.

"Progress of science and engineering, inventions in construction methods, improvements in water craft, discoveries in transmissions of electricity have brought us to the threshold of a new era in utilization of our water resources. We are able to undertake great projects with confidence of successful accomplishment. We have emerged from the long postponement of national construction imposed by the war and reconstruction; we have recovered so greatly in national wealth that we now have the capital to compass such projects as our expanding needs require and our undeveloped resources make possible."

Use of Clips on Wire Rope

IN ATTACHING clips to wire ropes in the formation of eyes, it is common practice to stagger the clips, that is to place bases and U-bolts of adjacent clips alternately against the "live" rope. This is incorrect because the vibrating and whipping of the wire rope in use tends to weaken the clip and perhaps break it when the U-bolt portion whose bearing surface is so much less than that of the base, is placed against the "live" rope.

Based upon a large number of experiments and experience extending over a number of years, the American Hoist & Derrick Company has prepared the following set of rules for applying clips. These are illustrated in the accompanying figure.

In order to prevent untwisting before cutting a wire rope, wind both sides of the contemplated cut with wire.

Always use a thimble in the loop of the rope except when the latter is carried around some object of sufficiently large diameter to prevent fracture of wires.

The length of the short rope from its end to the center of the loop should be equal to 30 times the diameter of the rope.

With the thimble in place, the loop may easily be bent around a short post or rod. It should then be wired temporarily, close to the eye until the clips are securely attached. This is illustrated at A.

The number of clips to be used depends upon the maximum capacity of the rope. The minimum number at each loop for running ropes is two; three is better. For guy ropes, three clips should be used.

All clips should be applied with their bases against the "live" rope.

The clip farthest from the loop should be applied first. Its distance from the wired end should be approximately four inches. This clip should be tightly fastened when it is applied. The clip nearest the loop should next be put on at a distance of four inches from

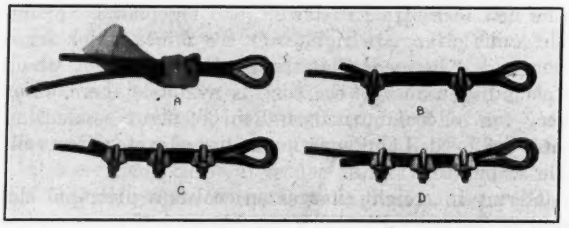


FIG. A. WIRING HOLDS LOOP IN PLACE TEMPORARILY
FIG. B. JOINT CORRECTLY ASSEMBLED WITH TWO CLIPS
FIG. C. THIRD CLIP PROPERLY APPLIED WITH TEMPORARY WIRING REMOVED
FIG. D. INCORRECT APPLICATION OF CLIPS SHOWING BASES OF CLIPS AGAINST "DEAD" ROPE

the end of the loop as shown in B. If placed too close to the loop it will shorten the bending angles of the rope and the wires will then be in greater danger of fracturing; it must not however, be placed so far away as to allow the thimble to drop out. The nuts of this clip should be tightened as tight as they will go, when the clip is first applied.

If three clips are to be used, the third one should be applied last. Before completely tightening these last two clips, it is desirable that some stress be applied to the rope. This will take up the slack and equalize the tension on all three clips. After the application of the stress, the last two clips should be thoroughly tightened. The finished end with clips correctly applied is shown at C. The incorrect application of clips is illustrated at D.

The clips should be attached in perfect alinement. Any twist or crookedness will place the clip at a disadvantage and impair its holding power.

The nuts must be tightened uniformly, each being given a few turns alternately.

The threads in both nuts and bolts should be oiled before tightening.

After the rope has carried a load for some time, the tightening operation should be repeated in order to make up for the reduction in diameter of the rope due to the stresses applied.

Refrigeration for New Madison Square Garden

New Dichloro-Ethylene Apparatus Used to Produce Huge Hockey Rink. By Austin C. Lescarboura

MENTION OF MADISON Square Garden brings to mind memories of by-gone sporting days, expositions, circuses, giant shows, national conventions and other events whose very magnitude called for a vast indoor arena surrounded by row upon row of seats for the spectators. This time, however, we are not to deal with the sentimental but rather with the altogether practical side of the New Madison Square Garden which, although far removed from Madison Square and the site of the old edifice, still carries that proud name and inherits the traditions of a thoroughly established American institution. Essentially, we are dealing with a cold proposition—ways and means for maintaining a comfortable indoor atmosphere for some 17,000 persons, even in the face of the stifling heat of mid-summer, while at the same time capable of converting an erstwhile floor into a skating rink with the approach of cool weather and thoughts of winter sports.

To begin with, just a word about the old Madison Square Garden, if for no other reason than as a basis of contrast. It was in 1889 that the first ground was

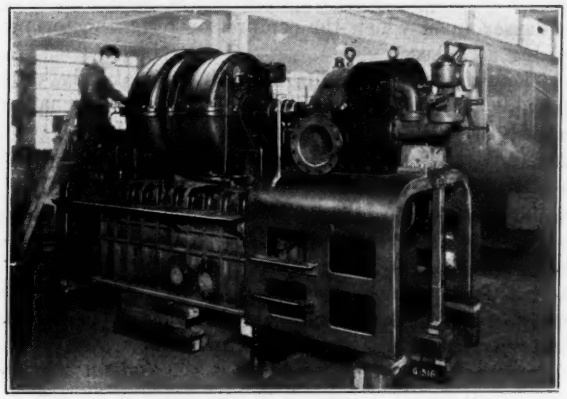


FIG. 1. ONE OF THE THREE CENTRIFUGAL REFRIGERATION UNITS OF 260 T. CAP. USED AT MADISON SQUARE GARDEN

broken for a $3,000,000 structure, which became known as Madison Square Garden.

Back in those early days, the subject of ventilation and comfort received scant attention. It was more or less left to chance, with the consequence that the thousands of spectators, packed into the vast building, were subjected to much discomfort despite the cool and cold weather of outdoors. In summer, on the other hand, an indoor show was almost out of the question and generally proved a real bugbear of the showman. There had not yet been evolved a method of cooling the air and reducing the humidity, such as we enjoy today in most public buildings.

Only a few years ago, an enterprising young Texan, destined to follow in the footsteps of the great P. T. Barnum of circus fame, came to New York. Tex Rickard made the most of the facilities offered by the old Garden and added not a little to the 35 yr. of its history brought to a close by the razing of the building in 1925. Tex, however, had more ambitious plans: he wished to be able to entertain greater masses of the public at one time; he desired to provide greater comfort for the spectators as well as the entertainers; he wanted to put on still greater shows, worthy of a far greater patronage. And so the New Madison Square Garden was born.

Within the brief period of nine months, the new structure rose on the site of an old car barn at 50th

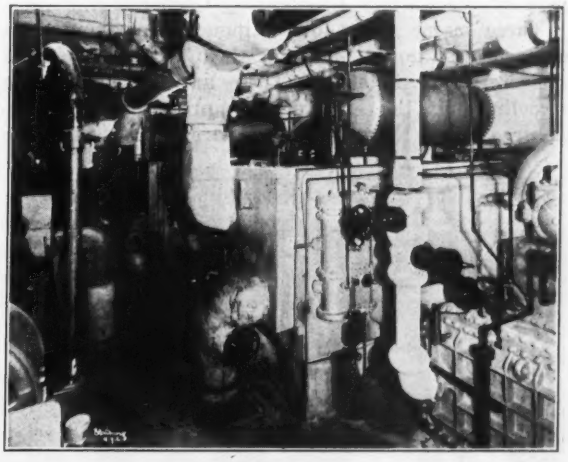


FIG. 2. A VIEW OF THE REFRIGERATING EQUIPMENT IN THE BASEMENT OF MADISON SQUARE GARDEN
The condenser may be seen near the floor at the extreme right. To the left of this, in the center of the picture, is the cooling chamber or evaporator

St. and Eighth Ave., in New York City. In December of 1925, the doors were thrown open to the public, with an invitation to attend the International Hockey Game, skating on a vast sheet of smooth ice in the huge indoor arena.

So the public was treated to a surprise. To produce conditions of favorable temperature and to reduce the humidity within buildings, refrigeration is required. But Tex had still another idea for the use of refrigeration—a sort of by-product. In his new Garden, he decided to provide a means of converting the great arena into a glassy surface of ice for hockey matches, by an ingenious adaptation of the refrigeration plant already called for by the air-conditioning installation.

So much for sport and showmanship. We must now plunge below the ice of the hockey rink in the New Madison Square Garden so as to get down into the engine room where the refrigerating equipment is at work.

First of all, let it be recalled that the refrigerating equipment here installed was originally intended for air-conditioning purposes, particularly in warm weather. Air conditioning, according to D. C. Lindsay, physicist of the Carrier Engineering Corporation of Newark, N. J., whose firm built and installed the refrigerating and air-conditioning equipment, has to do with the control of temperature, humidity and air movement within buildings. During the winter season, the process partakes mostly of warming and humidifying the air, while in

summer it consists of cooling and dehumidifying the air. The practice is not new. It is only within the past five years, however, that any extensive application of this practice has been made in public buildings, solely for the purpose of creating conditions of physical comfort. New Madison Square Garden is the first large auditorium to invest in such an extensive installation. In this installation all the customary objections to the installation of vibrating machinery and dangerous refrigerants have been eliminated by the introduction of centrifugal refrigeration which, in its operating characteristics, permits the use of a new and inoffensive refrigerant. This invention and development has been made by the Carrier Engineering Corporation.

Three major pieces of equipment, operating as a compact unit, go to make up the Carrier centrifugal refrigerating installation. These are the evaporating or cooling unit, the centrifugal compressor, and the condenser. In the New Madison Square Garden there are

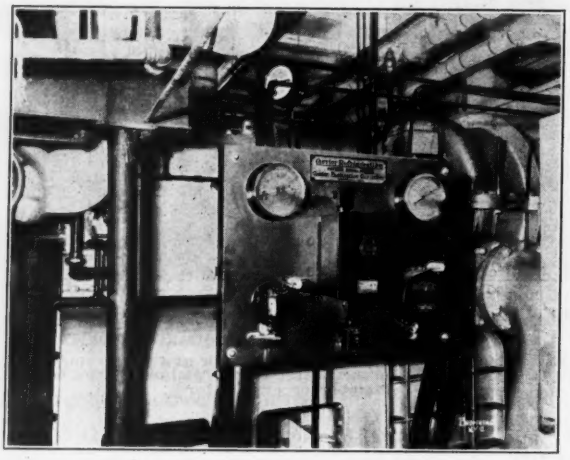


FIG. 3. AUTOMATIC CONTROL BOARD USED IN CONNECTION WITH THE REFRIGERATION SYSTEM AT MADISON SQUARE GARDEN

three 270-t. units installed, using for the refrigerant the new dichloro-ethylene, which is commercially known as dielene. This chemical is quite unlike the usual refrigerants, in that it is absolutely safe to transport in an open container, and, by the same sign, in the case of leaks it is not dangerous, because of its low diffusion characteristics; however, with the unique design of the refrigerating machines, it is practically impossible to have an outward leak, as the system operates under vacuum. The diochloro-ethylene refrigerant is an absolutely stable liquid at all ordinary atmospheric temperatures and pressures, and it is safe even when stored in uncovered containers. Its specific gravity is higher than that of water, and its vapor is 3½ times as great as that of air.

The compressor is a multi-stage centrifugal unit of relatively simple design, quite suggestive of the conventional centrifugal air compressors. The only parts subject to wear are the bearings. The compressors of the Garden installation are driven by Terry steam turbines, at a speed of 3600 r.p.m., with the turbines operating at a steam pressure of 115 lb. The exhaust steam is used for heating in the winter.

One of the outstanding features of this system of refrigerating is the small space required. The three units of the Garden installation require only a space of 32 by 54 ft., including all the brine circulating equipment and the steam condenser. The brine circulating equipment consists of three units, one for each machine. The pumps are of the centrifugal type, made by the Buffalo Pump Works and driven by General Electric 220-v., 40-hp., direct-current motors.

It may be mentioned that the refrigerant used is such that the condensing water at 90 deg. F. will produce condensation at a pressure of about 8 lb. Abs. This means, under extreme conditions, a pressure differential of 7 lb. between the intake and discharge sides of the compressor. The ordinary ratio of compression is usually less than 5 lb. Furthermore, from the condenser the liquid refrigerant returns to the evaporator or cooler under its own head. This completes the very simple cycle of operation.

The cooling of the brine or water is done in the evaporator, which is a tube and shell arrangement in which the liquid to be cooled is circulated through brass tubes, while the liquid refrigerant is sprayed over the tubes within the shell and caused to evaporate under a condition of about 25 to 28 in. of vacuum created on the intake side of the compressor. Condensation of the refrigerant vapor is produced within a shell and tube condenser upon which the compressor rests, the former serving as a base.

The refrigerating units are all automatically controlled. Since the requirements of the Garden change for all seasons of the year, with the equipment employed at times for freezing ice and at other times for cooling air, the control arrangements are remarkably flexible in order to take care of all conditions.

Thermostats are employed for controlling the temperature. The condenser water supply is controlled by thermostats. By this arrangement, it is possible to maintain constant cool temperature under varying loads. The control is also effective as regards compressor speed, within wide limits. So positive is the control in this installation that it is possible to cool water to 35 deg. F. without danger of freezing. Automatic control also prevents the freezing of the apparatus when the proper temperature is obtained for keeping ice on the skating floor.

One of the units operating at from 80 to 100-t. capacity can be used to surface the arena with ice. The brine is cooled to a temperature of approximately 11 deg. F. After the freezing is obtained, the temperature is maintained at 16 deg. About four hours is required to cool the masonry floor, and this accomplished, water is sprayed on and allowed to freeze in order to build up nearly $\frac{3}{32}$ in. of ice per hr. About 12 hr. is required to prepare the floor for a game of ice hockey. In actual practice, however, two machines are used for making the floor, while one machine will suffice to keep the floor in skating condition.

To remove the ice from the floor, all that is necessary is to heat the floor by circulating hot water or steam through the cooling pipes in the floor, with just enough heat to cause the ice to let go, after which it is broken up and swept from the floor.

In summer, the refrigerating system is employed to cool water for the air-conditioning equipment. This

equipment consists of fans, ducts, and spray type humidifiers, which wash, cool and dehumidify the air supplied to the arena, while the show rooms in the basement are provided with fans and cooling coils through which cooled water is circulated. With this system it is possible to supply nearly 400,000 cu. ft. of air per minute to the arena, or over 20 cu. ft. per min. per person. During the summer, there are times when the entire 800-t. capacity of the equipment is needed to maintain the proper conditions under which one can enjoy the performance.

The air-distribution system was installed and designed by Kimball-Woolfolk of New York. The dehumidifiers provided for the arena and the cooling coils used in the showrooms, were supplied by the Carrier Engineering Corporation. The steam for the turbines operating this refrigerating equipment is supplied by five 250-hp. boilers of the vertical type, fired with buckwheat coal. The exhaust steam from the turbines, as already stated, is used for heating in winter.

De-Concentration of Water Effects Marked Savings*

LATE in 1921, James O'Brien, chief engineer of the Passaic (N. J.) Metal Ware Co. investigated the conditioning of water by the Hall system and the use of the Hagan De-Concentrator, because of difficulties he had encountered with scale formation in boilers. After studying results obtained from several installations, he decided to give the system a thorough trial and, in September, 1922, a de-concentrator was installed.

In the manufacture of a variety of plain and decorated tin cans and boxes, the metalware company uses steam for process work, for heating and for driving two 150-kw. generator units. Hand-fired boilers are operated at 120-lb. pressure, two of the three 250-hp. boilers carrying the normal load. Operation is 24 hr. a day, 365 days a year, at somewhat above normal rating.

Makeup water comes from a well, the water having 14 grains per gallon hardness at the feed tank, and carrying considerable silt. About 55 per cent of the boiler feed is makeup.

De-Concentrator Operation

One de-concentrator, which is a combination of pump and filter through which boiler water circulates continuously, is employed. The piping is so laid out that this one unit can serve any of the three boilers, the de-concentrator being connected to one boiler for 24 hr., then quickly shifted to another by opening and closing several valves.

Prevention of boiler scale is accomplished by controlling the type of solids formed, not by regulating the amount of solids present in the boiler, although it is necessary to keep the concentration within reasonable limits. Before the present method was used, the boilers were blown down three times a day. Now twice is sufficient. Action of the de-concentrator does away with frequent blow downs.

Treating solution is made up in a tank and fed slowly but continuously, about 18 lb. of soda ash being used in 24 hr. Speed of the circulating pump is controlled according to filtering requirements, the sludge, principally calcium carbonate, with some silicate, iron and sulphate, being washed from the filter once a day.

Soda ash is the only chemical used, the amount needed being determined twice a week by tests, which take only a few minutes, to determine concentration of sulphates and carbonates in a sample of boiler water.

Scale Elimination

Hard scale is now unknown, only a thin sediment forming, which is easily washed out with a hose. Labor required for operation of the system is half an hour daily at a cost of 50 cents a day or $91.25 a year. Repair costs for 3.5 yr. have been $6.

Before, tube renewals averaged two a year, now it appears that only one tube in 4 yr. will be required. Cost of a tube renewal is $16.50. Boiler washing is reduced to one every 105 days from one every 35 days, cost of labor and coal per washing being $10.

Cost of the apparatus plus installation was $700, which, allowing 12 yr. life, gives $58.33 annual depreciation. Interest at 6 per cent, allowing for that earned by depreciation reserve is $22.75. Allow $10 a year for repairs; a gallon of oil a week at 30 cents or $15.60 for lubricant; and 13 lb. steam an hour for 24 hr. and 365 days at 30 cents per 1000 lb. gives $34.16 for steam. Eighteen pounds of soda ash a day at 3 cents costs $197.10 a year. Totaling the costs gives $429.19 a year or $1.18 a day, operation being 365 days a year.

Records show that the coal saving from having boilers clean is $1,405.25 a year; compound formerly used cost 90 cents a day or $328.50 a year. Tube renewals reduced at the rate of 1¾ a year at $16.50 per renewal saves $28.88 and boiler washing reduced from 35-day to 105-day intervals at $10 an operation saves $69.52 a year. Total saving shows $1,832.50 yearly as against an expense of $429.19 or a net saving of $1,402.96 annually at an investment cost of $700.

*From a survey by A. C. Nielsen Co., Chicago.

The United States Civil Service Commission announces an open competitive examination for chief plant engineer, applications for which must be on file at Washington, D. C., not later than December 7. The examination is to fill a vacancy in the quartermaster department, Fort Mills, Philippine Islands, at $3600 a year and quarters, and other similar vacancies.

Applicants must possess a degree in electrical or mechanical engineering, must have had at least four years of progressive professional engineering experience and must give evidence of ability and experience in handling a large power plant with all its problems.

The duties are to be in responsible charge of a large electric power and refrigeration plant on Corregidor Island and to superintend the work of maintenance and operation of the water systems. The work involves the direction of a large force of workmen, including prison labor. Competitors will not be required to report for examination at any place, but will be rated on their education, experience and fitness. Full information and application blanks may be obtained at the postoffice or custom house in any city.

Thinking before you act is all right if you don't think too long.

Liability for Infringement of Patents

PRECAUTIONS TO BE OBSERVED TO AVOID PATENT INFRINGEMENTS. BY LEO T. PARKER

IN VIEW of the numerous cases already decided, the law is well established that infringement of a patent is an unlawful or unauthorized use of a patented invention.

Recently a court in effect said that a person may not make a patented article as a whole or any part thereof, even for his own use, unless he acquired the original patented article or machine legally, and then he is permitted to make only such parts of the device as are actually needed for repairs. But the making of an old machine practically new is an infringement.

AMOUNT OF DAMAGES DUE PATENTEE

Therefore, if the owner of a power plant constructs a machine or a part thereof, or makes use of a patented process, he is liable as an infringer to the patentee. His liabilities may be the actual damages and loss of profits by the patentee, as well as the costs of the litigation. Moreover, the court may, if it so desires, enter judgment against the infringer for three times the amount of the verdict.

If after a complete and thorough investigation it appears that the owner of a patent has suffered damages, or that the infringer has realized profit from the sale of the invention, but the amount is not calculated with reasonable certainty, the court may receive and consider opinions from experts as to the amount rightfully due the patentee.

It is important to know that an infringement suit may be filed against an infringer either in the district in which the infringer has established his residence, or in the district in which the infringing acts are committed, if the infringer has a regular and established business there.

Generally, the suit first is tried before one judge in the United States District Court, after which it may be referred to three judges in the United States Court of Appeals. It is unusual that a patent case is reviewed by the Supreme Court of the United States.

CLASS OF PATENTS

Patents are said to be subdivided into the classes of machines or improvements: articles of manufacture; compositions of matter; mechanical processes; chemical processes; and designs. The laws relating to each of the first five classes are practically the same and each issue for 17 yr., without the privilege of renewal, unless specially authorized by Congress. A design patent issues for 3½, 7 or 14 yr., as the applicant may elect and relates to the exterior appearances of an article which must be ornamental, attractive, novel, useful and the result of the invention. As only a relatively few persons are interested in design patents, we shall not consider this class.

In a suit for the infringement of a patent the three fundamental questions are: Is the patentee the inventor of the device? Is the invention described in the specification of the patent? Is the device which is declared an infringement sufficiently covered by the patent? If these questions can be answered in the affirmative, generally, an infringer is liable who has appropriated all of the important advantages of the invention, whether by the ingenious application of equivalent mechanism or otherwise.

INNOCENCE DOES NOT AVOID LIABILITY

It has been held in numerous previously decided cases that innocence is no excuse and does not avoid liability. In a recently decided case, the court held that if a party who manufactures an article or machine is an infringer, and sells to a wholesale firm, who sells to a retail dealer, who in turn sells it to an individual, they are all infringers and liable as such even though neither of them was aware of the existence of the patent. But it is well to know that where the article is made under a process patent, the innocent purchasers are not liable, because the court assumes that it is improbable for a purchaser to know whether or not an article is made under a process patent.

In purchasing equipment, a very safe rule to follow is to decide whether or not a machine or part infringes another: A mere change of the form of a device will not avoid infringement, particularly where the principle of the patented invention is utilized. Furthermore, infringement cannot be avoided by adding to a patented article, unless a new and unexpected result is produced by the added element.

In other words, where a patent is issued to a patentee and someone later improves it by taking the same invention and adding something to it, the last inventor is not permitted to manufacture, sell or use the invention, unless he obtains permission from the original patentee. On the other hand, where it is possible to eliminate an important element of a patented invention, the remainder may be used without the maker or user being liable as an infringer.

For instance, in a recent litigation it was disclosed that a manufacturer attempted to avoid a patent by appropriating the basic idea and adding another part by which a considerably more desirable and advantageous invention was produced; the court, however, in effect said that improving a patented device does not avoid infringement. Furthermore, the improver of a patented invention cannot appropriate the original invention, even though he has obtained a patent on the original invention and the improvement.

MERE SUBSTITUTION DOES NOT AVOID INFRINGEMENT.

Frequently litigations have resulted where one part of an invention is substituted by another. This phase of the law is that where a person substituted an element for the equivalent one described in the patent, such a change does not avoid infringement unless new, useful and unexpected results are effected by the substitution.

For example, various cases have held that the following elements are equivalent to each other and that the substitution of one for the other will not avoid infringement of a patent: A positive and a friction gear; a ball-bearing and a roller-bearing; a spring and a pivot; a weight and a spring; a worm-gear and a bevel-

gear; a cam and a toggle joint; a sprocket-drive and a belt-drive; spiral-gears and miter-gears.

On the other hand, it has been held that when a part is different in construction, and cannot be substituted for the part shown in the patent, such a part is not a mechanical equivalent and may avoid infringement. The logic of this is appreciated when it is considered that when an ordinary and known element cannot be substituted, inventive ability must be exercised to produce a part to take its place.

Pioneer Patents

There has been considerable discussion relative to the term "basic" or "pioneer" patent. Generally, a pioneer patent is deemed to be one which relates to an absolutely new machine or device; it has been held, however, that a pioneer patent need not be distinctively different from other devices previously used, as it may relate to a small new portion of the previously used machine. In another case the court held that a patented device which greatly reduces the cost of manufacturing an article is a pioneer patent, because where an invention is capable of producing so highly desirable results, it must be distinctly different from the mechanism previously used for the same purpose.

There is, however, a fine line of distinction between "invention" and "mechanical skill." As is well known, a patented invention must represent the application of inventive ability.

Therefore, a device which does not require inventive ability to produce is not patentable. Various examples, have been given in numerous past decisions relative to the kinds of inventions not patentable. For example, the various courts have held that a valid patent cannot be obtained on a device which is produced by merely making an old article different in shape; or stronger; or larger; or longer; or making in one piece that which is old in two pieces; or vice versa; or making a square article round; or using an I-beam instead of channel beams; or increasing the number of parts; or the like.

Simplicity, however, is often mistaken for mere mechanical skill and it has been held on numerous occasions that simplicity of an invention is the highest trait of genius, which will not bar a patent.

Generally, it has been held that if by simplifying a machine or device the result is advantageous, a patent may be obtained. Moreover, sometimes an apparently slight improvement of an invention may result in a valuable patent. This is true particularly if a new and useful result is accomplished which has been sought for by skilled mechanics for a long time.

A device to be patentable must be useful and adaptable to utility. For instance, a patent for a belt which was constructed in such a manner as to protect the heads of the rivets, used to fasten a belt, was declared void, for the reason that it was shown to the satisfaction of the court that no advantage was accomplished by protecting the rivet head. The so-called perpetual motion machines are not patentable. As a matter of fact, an application for such a machine will not be accepted by the Patent Office, unless a working model can be submitted for the purpose of demonstrating its operativeness.

But a person who appropriates a device and infringes it cannot avoid infringement by questioning the usefulness of the invention. Recently a court held that if the infringer found it desirable to use the patented invention, the utility of the device is presumed.

In another instance the user of a patented invention attempted to avoid infringement of a patent by using a different material in the construction of the article. The court held, however, that the use of a different material which does not produce a new and useful result does not avoid infringement. For instance, it has been held that the use of wood instead of iron; paper instead of fiber; celluloid instead of glass; aluminum instead of steel; sheet metal instead of cast metal, and rubber instead of paper involves no invention and will not avoid infringement.

On the other hand, it has been held that to substitute a low grade of steel for tempered steel involves invention, where new, beneficial and unexpected results are obtained. Also, where the improved results were effected by the substitution of a metal part for a rubber part, the court decided that invention was involved and infringement was avoided.

The law is that it is not necessary to notify an infringer to discontinue the infringement of a patent before the patentee may instiute legal proceedings for damages and profits. But if the devices which are marketed by the patentee are not properly marked "Patented" with the date of serial number of the patent, no damages may be had for infringement until the infringer has received notice from the patentee to discontinue the infringement and fails to do so.

Where a patentee delayed 6 yr. in filing a suit for infringement, the court held that he was entitled to recover damages and the profits earned by the infringer for the full number of years. In another case, however, the court said that an infringement suit must be brought within a reasonable period of time, but that a delay of 6 yr. or less time should not bar recovery. But in another case the court held that a delay of 10 yr. in bringing a suit for infringement was not reasonable.

Patented Articles Must Be Marked

Another important point of the patent laws and one which has produced confusion in the minds of various inventors and manufacturers is that a patent infringement suit cannot be entered until after the patent is allowed. The law says that it shall be the duty of all owners of patented articles to mark "Patented" with the day and year the patent was granted on the article. But the law also says that every person who marks the name or any imitation of the name of any person or firm upon a patented article, without the consent of the owner of the patent, or who marks on any such patented article the word "Patented" or any similar word with intent to counterfeit the mark or device, without having license or consent of the owner of the patent, or who in any manner marks the word "Patent" or any similar word as "Patented," for the purpose of deceiving the public shall be liable to a fine of not less than $100, with costs, for each article so marked; and one-half of the fine shall be paid to the person who sues for the same; and any person may bring the suit.

Where an article is simply marked "Patent Applied For" or with a similar notification, the patentee is not permitted to recover damages from a maker or user of the invention; but after the patent is allowed, the sit-

uation is changed and the patentee may recover damages from the date the patent is allowed.

Sometimes the actual damages awarded to a patentee is measured on the basis of royalty, but if no other means are available, the court may decide a reasonable amount for damages in accordance with the evidence submitted.

An important consideration in patent infringement suits is: What do the patent claims actually cover; and is the suit for infringement of a whole machine or only a part of a machine? In a case where this latter point was involved, the court in effect said that if the infringement is for a patent improvement, or a part of a machine, then only the damages and profits relating to the particular part infringed is recoverable and that the profit on the whole machine is not important in determining the amount of the verdict.

It is important to know that where a patent is issued in the names of two or more inventors, neither of the inventors is permitted to sue the other for infringement of the patent. Furthermore, either of the inventors has the privilege and legal right to manufacture and sell the invention or license it to another manufacturer, without accounting to the other inventors.

Of course, if a special contract exists between the inventors and specifies that neither shall manufacture, sell or license the invention without the approval of the others, the situation is different.

When Patent Is Not Enforceable

Irrespective to all things the maker, seller or user of a patented invention is not liable for infringement if any of the following points may be proved:

(1) If for the purpose of deceiving the public, the description and specification of the patent application contains less than the whole truth relative to the invention, or more than is necessary.

(2) If the owner of the patent obtained the patent which was for a device actually invented by another person who was using reasonable diligence in perfecting the same.

(3) If the invention was patented or described in some printed publication prior to the time the owner of the patent invented the device or more than 2 yr. prior to the time his application for a patent was filed.

(4) That the patentee was not the original or first person to invent or discover the patented article.

(5) That it had been in public use, offered for sale or on sale in the United States for more than 2 yr. prior to the time when the patentee filed his application for a patent.

(6) That the invention had been given or abandoned to the general public.

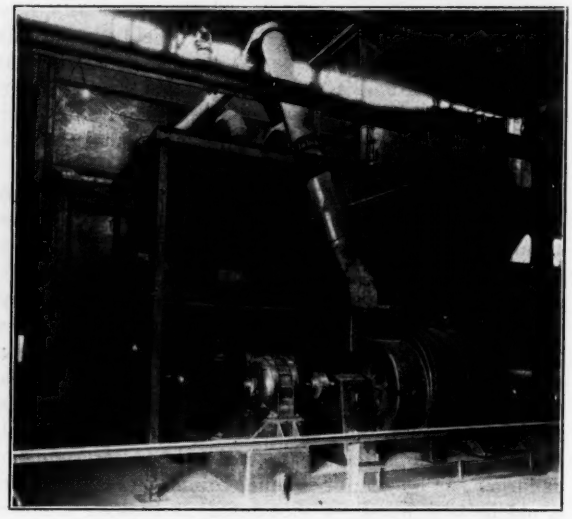
Flow Measurements with the Flat Plate Orifice

On page 999, September 15, 1926 issue, the constant 0.569 appearing in the third line, first column and the second line, second column should read 5.69. Again in the last paragraph, first column of the same page, the sentence, "The upstream pressure tap should be located 6 in. and, from Fig. 3, the downstream tap 0.44D or about 2⅝ in. from the center of the flange" should read "0.675D or about 4 1/16 in. from the center of the flange."

Unit Pulverizers for Paper Mills

FIVE PULVERIZED coal fired boilers will eventually supply power, heating and process steam for the River Raisin Paper Co.'s several plants at Monroe, Mich. One of these boilers, No. 1, as shown in the illustration, has been in service several weeks, the second is being erected and the remaining ones will be installed in order.

Erie City three-drum boilers with Erie City pulverizers and burners are being used. Each boiler is rated at 1296 hp., set in a steel shell and has four burners supplied by two unit pulverizers. Approximately 3.5 cu. ft. of furnace volume above the ash pit water screen is provided for each rated boiler horsepower. Ash will be taken care of by an Allen-Sherman-Hoff Co. ash

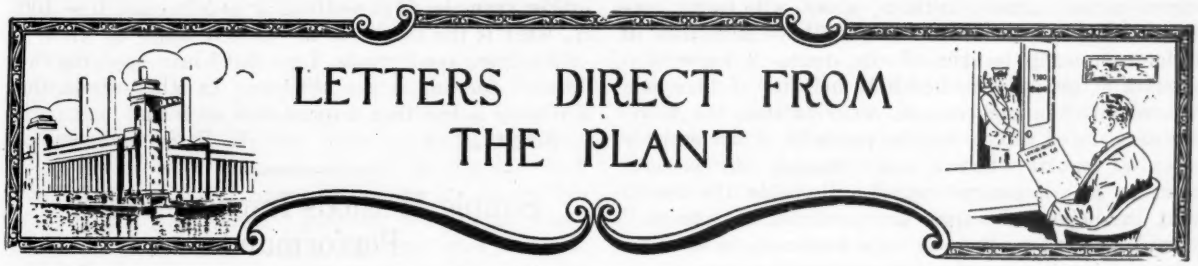


EACH BOILER HAS TWO UNIT PULVERIZERS, EACH ONE SUPPLYING TWO BURNERS

sluice and a 900-g.p.m. centrifugal pump which will pump the ash and water mixture to an outside settling basin.

Beaumont coal handling equipment has already been installed. A 45-t. per hr. skip hoist delivers coal to two 200-t. steel bunkers for distribution to the various boilers by two weigh larries. To accommodate the boilers and equipment the roof of the boiler room had to be raised several feet and as natural draft will be used a new stack was built.

Saturated steam at 160-lb. gage will be generated and metered with General Electric flow meters. At present the new boiler is operating in parallel with the old boilers and until No. 2 boiler is completed it is impossible to proceed with construction work in the third new unit. When completed, the new plant will supply steam to the several sections of the plant which are now supplied by individual boiler rooms. Later on a turbo-generator, possibly 2000 kw., will be installed for parallel operation with the engine generator sets and to carry the electrical load when low-pressure steam demand and electrical demands do not balance.



Losses Due to Light Loading of Steam Engines

MUCH HAS been written about the effect of overloading steam engines but little has been said about the lack of economy accompanying the operation of steam engines at much below their rated capacities.

Under light load the percentage of condensation is considerably increased. For example: in a noncondensing engine, operating under 80 lb. per sq. in. gage pressure, the loss due to condensation is clearly indicated in the table herewith:

Cutoff per cent	Condensation Loss, per cent	Water Rate, pounds	M. E. P.
50	14	28.38	60.44
30	22	26.29	43.97
20	26	25.68	32.02
10	34	29.88	16.07

It is evident from the above that an engine will do nearly four times as much work at 50 per cent cutoff than it will do at 10 per cent cutoff. This means that at 50 per cent cutoff an engine will do the same amount of work that an engine four times its size operating at 10 per cent cutoff would do.

Strength of parts cannot be reduced because of early cutoff, because the parts must be designed to withstand the stresses met at the beginning of the stroke. The initial pressure is the same, in all automatic cutoff engines, whatever the per cent of cutoff. The only way in which increasing the point of cutoff affects the bearing pressures is, that the length of time of application of the maximum force at initial steam pressure is increased, hence there may be an increasing tendency to heat the bearings.

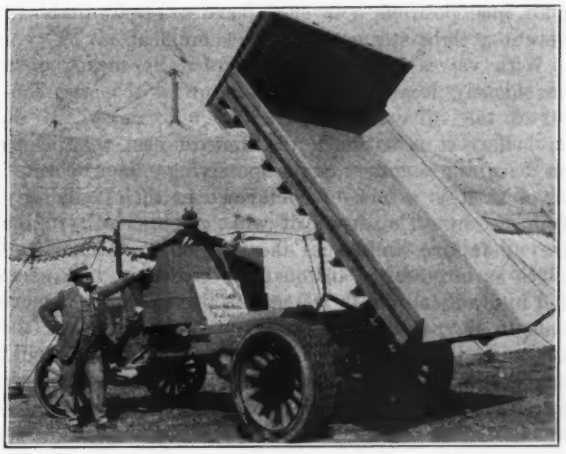
Where two or more engines are installed in a plant, it is clear, therefore, that the best combinations based upon their several water rates, should be determined and the engines cut into service in accordance with the best net water rate.

Toronto, Canada. JAMES E. NOBLE.

Truck Specially Built for Hauling Boulders

BUILDING great dams requires the handling and transportation of large rocks and dump trucks are required to transport this material. Many boulders are so large, however, that a single one may constitute a load of many tons. Loading and dumping of such material quickly destroys the ordinary dump body on the motor truck.

In the illustration herewith is shown a truck body that has been designed and built especially for this class of work. The body has an exceptionally strong structural steel subframe, with unusually sturdy reinforcements and a flooring of special steel plate having spring



HEAVY CONSTRUCTION, HYDRAULIC LIFTS AND DUMPING QUALITIES MAKE BOULDER TRANSPORTATION A SIMPLE MATTER

steel qualities. Trucks of this kind, provided with hydraulic hoisting gears and dumping arrangements, were used on the Feather River Hydro Electric Power project in California.

San Francisco, Cal. C. W. GEIGER.

Motor-Operated Valves

MOTOR-OPERATED valves is a subject that in my opinion should be given considerable thought. The article in "Power Plant Engineering" under date of September 15, has caused me to wonder why there are so few plants equipped with motor-operated valves. My personal experience with hand-operated valves has always given me a longing to hold a position in a plant in which the big valves are motor-operated.

Most of the boiler men to whom I have spoken put no faith in motor-driven valves. They usually have only hand-operated valves in their plants and they realize, from both an operating and financial standpoint, the futility of asking for a change. In a majority of plants, the steam valves are seldom operated; they have stood in one position, open or closed, for long periods. I know of many valves that have not been closed for over 5 yr. It will be quite a job to close them tightly now. Even if the spindles and gates are loose, the accumulation of sediment on the seats will prevent a seal. In case of a break-down or quick shut-down under such

circumstances, drastic methods, which will entail considerable loss of time and steam, will have to be used in order completely to shut off the steam. I know of a number of instances in which 10 hr. time of four men was required in each case in order to close the valve. Motor-operated valves, may be partially, if not entirely closed at regular intervals, and "freezing" in one position, by this means, prevented. Probably the reason that hand-operated valves are permitted to "freeze," particularly where there is little headroom to work, or where the valves are located overhead in some inconvenient place, is that it is such a job to operate them; hence they are usually neglected. With steam that contains some soda ash or sediment carried along mechanically, it does not take long to build up a hard crust around the gate or stem of the valve. If the valve is in an open position, a layer of hard sediment that will prevent a tight steam seal will be built up.

With valves that can be operated by means of a conveniently located push button or switch, the control of the valve is always at one's command. I do not believe it is so much the item of cost that keeps the designing engineer from specifying motor-operated valves as it is a lack of confidence in their reliability of operation. The dread of what might result in the case of failure, influences them unduly. I have seen valves as large as 54 in. on gas lines, that were operated hydraulically with water at a pressure of not more than 45 lb. per sq. in. No hand wheels were on the valves, so that in case of failure, a real delay would have resulted; but in the 7 yr. of their operation no loss of time had been experienced. There is no real cause for a lack of confidence in power-operated valves.

Large water valves, as a rule, do not stick, because they do not collect much material that hardens. Motor equipping such valves represents a labor-saving investment that will bring a good return. It well deserves consideration.

Pittsburgh, Pa. C. W. STEVENS.

Length of Crossed Belts

MOST OF THE formulas that one finds for computing the length of cross belts are rather complex involving the use of an angle, and the sine or tangent of that angle, making the handling of the formula exceedingly difficult for most of us and requiring the use of a handbook or table, etc.

Below is a formula that I recently developed which avoids the angle entirely and which gives surprisingly close results for most combinations of cross drives. The formula is:

$$x = 3.1416\ (R+r) + \frac{2\ (R+r)^2}{L} + 2\sqrt{L^2 - (R+r)^2}$$

Where x = Length of cross belt in inches;
Where R = Radius of large pulley in inches;
Where r = Radius of small pulley in inches;
Where L = Distance between shaft centers in inches.

For sake of comparison, if you want to compare and if you know how to use trigonometry, here is the "rational formula" which gives exact results:

$$x = (R + r)\ (3.1416 + .0349A) + 2L \cos A$$

Where A = angle whose sine is $\frac{R+r}{L}$

For example: If R = 10 in.; r = 5 in.; and L = 100 in., what is the length of the crossed belt?

Applying my formula, I get 249.1 in. Applying the "exact" formula, I get 249.3 in. In other words, the difference is less than a quarter of an inch.

Newark, N. J. W. F. SCHAPHORST.

Simple Methods Improve Boiler Performance

THAT HAND-FIRED boiler plants offer great opportunities for saving, is recognized by many engineers; but they too often assume that this fuel saving must be accompanied by elaborate changes in equipment, or by the installation of costly instruments. If they ask for changes that will involve the expenditure of several hundred dollars, or in some instances thousands, and are unable to secure the consent of the owners to their plans, they should at once direct their attention toward another plan that will impress the management more favorably.

It is a mistake to talk to the president of the company, whose life training has been devoted to manufacturing and marketing some special product, in terms of pounds of coal per kilowatt-hour, or still worse, percentages of excess air, all of which the engineer hopes to improve by the changes proposed. While the engineer may be forever thinking in these terms, because he is an engineer, the owner thinks in terms of money, the universal language of business men.

In the average hand-fired plant, the main reason for excessive fuel bills is not lack of proper equipment nor lack of competent firemen and engineers, but is the lack of appreciation of the efforts of the boiler room crew, on the part of the owners, and failure to realize that in the majority of the crew, there is considerable latent ability that may be brought out by a proper attitude on the part of the man higher up. It is asking a lot of a fireman to expect him to increase his efforts and take an absorbing interest in his work when at the same time his compensation is 10 to 20 per cent lower than the rate paid by other plants in the same locality and frequently lower than is paid by the same company for other classes of work requiring less intelligence and training.

In one plant, in which I served as chief engineer, an investigation showed that fuel was being wasted by improper firing methods. The boilers were operated at full load from 7 a. m. to 5 p. m. and the fuel consumption was about 6 t. daily. Only natural draft was available, notwithstanding the heavy firing. Black smoke and holes in the fuel bed indicated that the coal bill could be reduced by the adoption of a different system of handling the fires.

One man who appeared to be the most intelligent of the three shift firemen alternating weekly and who, I thought, would take the most interest in my plan, gave me a slant at the problem that I had not previously thought of. He said, "They expect us fellows to take an interest in our work and work our heads off to save money for them, when we are not even getting laborers' wages. Three weeks before you came, a man quit to take a janitor's job in the new office building down the street at more money than he received here. Recently I was offered a laborer's job on the new bridge

here at $5 more than I now get, and no night shifts to work on either."

Obviously these men had good reason to be discouraged with their prospects in this plant and I decided that they must first acquire a different viewpoint before they could improve their operating methods. When the fireman referred to came on the day shift the following week, I proposed that he try my system of firing for just one day, pointing out that he would learn enough to repay him for any extra work involved, which knowledge would prove useful to him in other plants at some future time.

By carrying lighter fires and keeping the fuel bed free from holes, the coal consumption was reduced by one ton out of a total of five. I told him I appreciated his extra effort and co-operation and asked him if he thought he could keep it up if he was paid a bonus for doing so. He was at once interested and with the prospective bonus in view he pointed out several defects around the boiler room which could be remedied easily and still further cut the coal bill.

Since the firemen could save a ton of coal a day, the operating costs could be reduced $7.50 daily, provided they would be willing to keep it up day after day and not drop back into their former wasteful habits. I reasoned that the owners should be entirely willing to give the men part of the saving as a bonus inasmuch as it meant a reduction in final costs and it is the final net cost that counts, rather than any one item of cost. The other two firemen on hearing of the bonus plan I had in mind got busy at once and improved their firing to such an extent that the reduction of one ton daily was maintained throughout a period of three weeks during which time each fireman worked a week on each shift, which gave me a chance to observe them individually.

With an abundance of confidence in the success of my plan, I went to the office and handed a complete outline of my idea in writing to the manager, who was also the largest stockholder. It was clearly shown in this outline that in the last three weeks we had saved 21 t. of coal, which reduced the costs in our department $157.50, and I recommended that this saving be divided between the men and the company on the basis of 40 per cent to my firemen and 60 per cent to the company.

Was my plan approved? It was not! In spite of the careful preparation and excellent reasons advanced it was turned down. I had also been careful to find out beforehand that the production in the factory was up to the usual amount and the manager had to admit that it was the extra effort on the part of the firemen alone that was responsible for the reduction in costs. But he was emphatic in his refusal to give the firemen extra compensation, saying, "We are paying those men down there to work 8 hr. a day and we expect them to give their best efforts every minute in return for the salary we pay them; if they are not satisfied with the wages we pay them, they may quit. I pay my men all they are worth!"

In vain I showed him that the sum of the bonus and coal bill during the last three weeks was less than the coal bill without a bonus as before and pointed out that the bonus and wages together were no greater than the salary paid firemen in some of the more efficient plants in the locality. But he would consider no plan that meant paying the firemen higher wages and stated that since it had been demonstrated that coal could be saved, he would henceforth expect them to keep the consumption down to the lowest possible figure. I was thoroughly disgusted with the stand he had taken and informed him in no uncertain terms that he was not qualified to judge the value of a good fireman; that if he persisted in his refusal, the men would lose interest and the coal bill would mount to the former figure. But he refused to discuss the matter further and I went back to the boiler room to report the results of the interview. Needless to say the firemen were disappointed and discouraged at the outcome and in a few days the rate of coal consumption greatly increased.

Having numerous other duties that required attention, I could not spend much time in the boiler room and in a few days the manager called me to the office. He wanted to know why those "lazy devils" were lying down in the boiler room and who caused the coal bill to jump 20 per cent in a week.

I replied, "You are the man who is responsible for the high coal bills of this plant, because you regard your judgment as infallible. The men have done their part. It is all very well to say men should give all there is in them to their employer, but where can you find men to do it for an indefinite period unless their efforts are appreciated? I have come to the conclusion that there is no future in a company like yours and here is my notice to take effect Saturday noon."

I was offered a slight increase in salary to stay, as he knew that no local engineer would work for him, but I refused it as I felt that the sooner I broke away from him the better for myself. This same manager frequently addresses Booster Clubs and similar gatherings on the subject of efficiency of the hundred per cent variety.

Springfield, Mass. A. F. SHEEHAN.

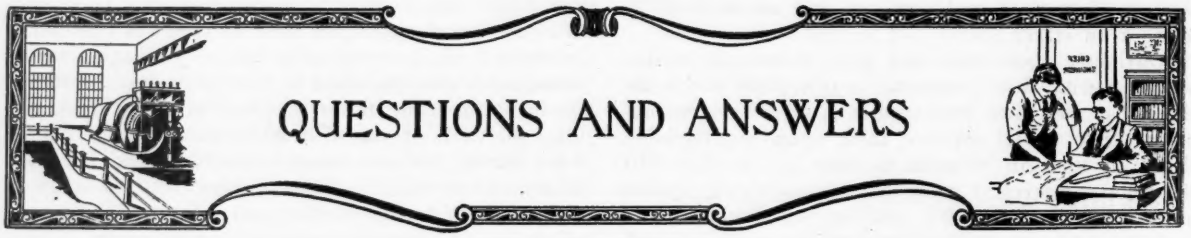
Automatic Regulation Pays

POWER PLANTS during the past 10 yr. have become almost automatic. Not long ago I stepped into a comparatively small plant and found nobody in the engine room; the chief was not at his desk in his office, and there was nobody in the boiler room. I then went into the backyard and there found the entire force including the chief looking at and commenting upon the beauties of one of the most gorgeous rainbows I have ever seen. This is as it should be. When there is something worth seeing, we should all have an opportunity to see it. One cannot do one's best by eternally and monotonously watching an engine or turbine or shoveling coal by hand.

In this plant, while the operators were out, the electrical end was "regulating itself"; the engine governor was taking care of the engine speed; the stokers were automatically firing the boilers; and, boiler feed regulators were taking care of the feed water. Temporarily everything was OK and the force had nothing to worry about while admiring the rainbow.

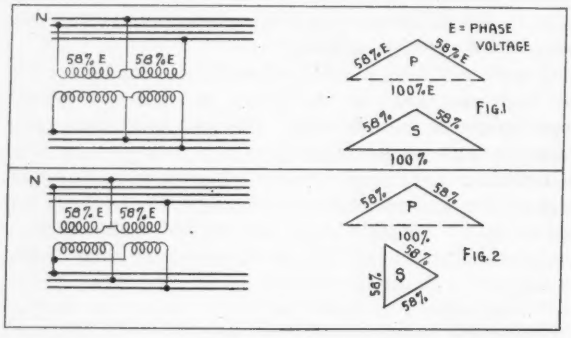
Not only does automatic regulation make life more livable for operators—it is a good investment. Take for example the installation of boiler feed regulators. In an actual instance which has just been brought to my attention, a concern, by installing automatic boiler feed regulators and reducing the number of men needed in the boiler room, saved nearly $10,000 a year.

Newark, N. J. N. G. NEER.



Transformer Connections

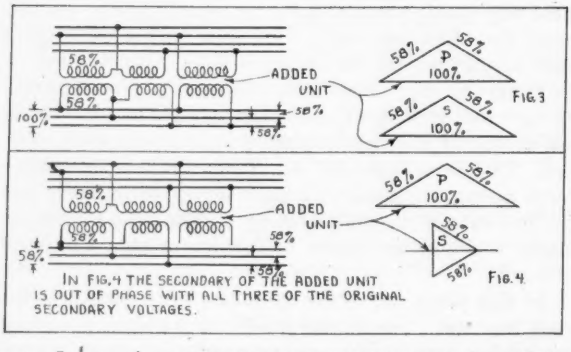
IN AN ARTICLE on Transformer Connections by V. E. Johnson, which appeared in the December 1, 1925 issue, there was shown a connection in which two single-phase transformers were connected between the neutral and



FIGS. 1 AND 2. CONNECTIONS IN WHICH TWO TRANSFORMERS ARE CONNECTED ACROSS TWO LINE WIRES AND THE NEUTRAL OF A 3-PHASE, 4-WIRE CIRCUIT

two of the line wires of a 3-phase, 4-wire circuit. This arrangement, it was stated, provided three-phase currents at the secondary of the transformers.

I would like to know whether three single-phase transformers could be connected across the neutral and



FIGS. 3 AND 4. CONNECTIONS SHOWING THREE SINGLE-PHASE TRANSFORMERS ACROSS TWO LINE WIRES AND THE NEUTRAL OF A 3-PHASE, 4-WIRE CIRCUIT

two line wires in some such manner so as also to provide three-phase current? R. S.

A. Without knowing what you wish to accomplish by connecting three transformers across the neutral and two line wires of a 3-phase, 4-wire system, it is impossible to answer this question accurately; however, the following discussion may be of some use.

There are two fundamental ways in which two transformers may be connected between the neutral and two-line wires of such a system. These are called "Y open Y" and "Y-reversed open Y." These are shown in Fig. 1 and Fig. 2, respectively. It will be seen that the former does not produce a symmetrical secondary voltage, while the latter does. The voltage diagram shows the voltage relations that exist.

If now, a third transformer be added as in Fig. 3, it will be seen that the voltage relations are correct for banked operation, and that such a group will be operative. On account of the unsymmetrical secondary voltages, such an arrangement is of little practical value.

On the other hand, if an attempt be made to connect a third transformer to the group in Fig. 2, the phase relations will be wrong, as per the voltage diagram in Fig. 4, so that this scheme will be inoperative.

The third transformer could, of course, be connected in multiple with either one of the units in Fig. 1 or Fig. 2, in which event the voltage relations would be unchanged.

Milwaukee, Wis. V. E. JOHNSON.

Steam Problems from Massachusetts Examination Questions

KINDLY LET me know the answers to the following questions which were given at a Massachusetts first class engineer's examination.

1. In a Manning boiler, is the pitch of the stay bolts measured from the outside or inside?
2. In a butt and double strap joint, why is the inside strap wider than the outside strap?
3. What would cause water to get into the cylinder of an engine connected to a barometric condenser which has no overflow pipe connection?
4. Why is lap given to a Corliss engine valve?
5. Why can't a slide valve cut off earlier than 5/8 stroke?
6. Why are engines made compound?
7. What is "re-evaporation" and where does the heat come from that causes it?
8. Why are some turbines of the impulse type and others of the reaction type?
9. What is the idea of pressure and velocity staging in steam turbines? C. L. P.

A. Pitch of stay bolts in a Manning boiler is measured as of the sheet when it is flat. This would mean that the pitch is slightly increased on the outer side and decreased on the inner.

2. The outer strap of a double strap butt joint in a boiler is made narrower so as to decrease the calking pitch. If the outer strap is as wide as the inner, the outer plate is apt to rise up between the rivets during the calking operation, because of the greater pitch of the rivets along the outer edge. To overcome this the

outer plate is sometimes milled at the edge so that this edge is about the same distance from rivets in all of the rows. This is called a "saw tooth" construction and is expensive.

3. If caused by the condenser, as you indicate, water may be drawn into the cylinder of an engine during the suction stroke if the vacuum is broken in the connecting barometric condenser.

4. Without "steam lap" that is lap on the steam side, in any steam engine, cutoff would not occur until the end of the stroke. When lap is added the eccentric is advanced on the shaft an amount equal to the lap angle or enough to bring the position of the valve at the end of the stroke to a point at which it is just ready to open. It is common practice to add "lead" also, that is advancing the eccentric a little more, so that, at the beginning of the stroke, the steam port is open an amount equal to the lead. This permits admitting steam before the end of the stroke in order to cushion the moving parts and better enable the cylinder clearance space to be filled with steam at high pressure at the beginning of the stroke.

5. The easiest way to see why a D slide valve cannot cut off earlier than about ⅝ stroke is by referring to a valve diagram such as the "Bilgram" which is illustrated in Fig. 1. In this, A B represents the stroke of the engine, and A_1 B_1 the diameter of the crank circle. Oo is the throw of the eccentric, e d the lead, oL the steam lap, ol exhaust lap and oOB_1 the angle of advance. For the figures as shown the lead is $\frac{1}{16}$ in., eccentric throw 1⅛ in., steam lap ½ in., exhaust lap ⅛ in., negative. Steam port opening at extreme travel is shown by Og ⅝ in. cutoff position head end for the crank is at Oa_1, and piston positions at a for cutoff at h for release head end and at b for compression, crank end.

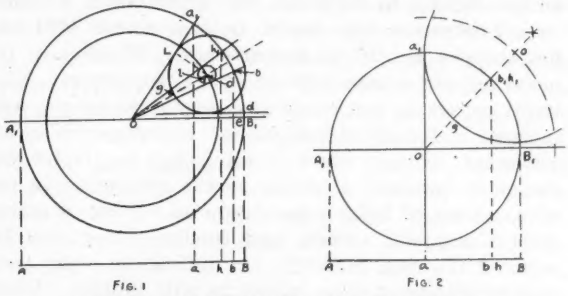


FIG. 1 FIG. 2

BILGRAM DIAGRAM FOR D SLIDE VALVE
DIAGRAM FOR CUTOFF AT ½ STROKE

To get cutoff at ½ stroke as shown in Fig 2, and keep port opening ⅝ in., eccentric throw has to increase to 2 in., Oo, steam lap to 1⅜ in. With exhaust lap zero, this brings release and compression at b and h, 85 per cent of the stroke. As cutoff is brought earlier, travel and lap increase, thus increasing the size of the valve and the power used up in friction. Also it is difficult to get proper release and compression. Because of the limitations of the D slide valve, cutoff is not usual, therefore, at earlier than ⅝ stroke.

6. Compounding a steam engine is done to permit of greater expansion of the steam without too great change in temperature which would cause initial condensation and re-evaporation due to the great changes of temperature of the cylinder walls.

7. Re-evaporation in a cylinder causes condensate to be turned again into steam. The heat which causes this evaporation comes from the cylinder walls which have not cooled off as fast as the steam within them, as in the case of too great expansion.

8. There are three fundamental types of steam turbines; 1. impulse type, 2. reaction type, and 3. combination of impulse and reaction type. The first operates through the impinging action of a stream or streams of steam, the steam in this case expanding in the nozzle or nozzles; the second receives its energy through the expansion of the steam in the veins; the third employs both of the above principles. The first type operates at a very high speed hence is comparatively small for a given horsepower but in order to drive other machinery it is necessary to employ some type of reduction gear. A reaction turbine may be direct connected to an electric generator.

9. As to staging, impulse turbines may be classified into four types as: 1. single stage, 2. velocity stage, 3. pressure stage, and 4. velocity and pressure stage. A stage signifies that part of a steam turbine in which a drop of pressure occurs with the generation of kinetic energy, together with such succeeding blades and passages where no further drop of pressure occurs. Staging refers to the redirection of steam, by means of a set of stationary blades to another set of rotating blades. Through this means, some of the force of the steam which would otherwise be lost by the discharge of the steam as in the single stage, is returned to the rotor. Velocity staging refers to the redirection of the force due to the velocity of the steam while pressure staging refers to the redirection of pressure due to expansion.

Calculating the Proper Size of a Safety Valve

IN AN examination for an engineer's license, I was asked how to determine the size of a safety valve for an 84-in. h.r.t. boiler. Does not this depend upon the amount of grate surface? How is it figured?

E. E. L.

A. One of the factors in the formula recommended in the Boiler Code of the American Society of Mechanical Engineers, is the total fuel burned per hour, which is influenced by the grate area. The formula referred to is based upon the heat generated from fuel burned, a boiler efficiency of 75 per cent and Napier's formula for flow of steam through an orifice into atmosphere.

For valves with 45-deg. bevel seat, the formula is:

$$D = \frac{C\,H}{160,856\,P\,L}$$

For valves with flat seat at 90 deg.:

$$D = \frac{C\,H}{227,487\,P\,L}$$

where D = dia., of valve seat, in.
C = total fuel burned per hr. (lb. or cu. ft.)
H = heat of combustion (B.t.u. per lb. or cu. ft.)
P = absolute boiler pressure (gage + 14.7) lb. per sq. in.
L = vertical lift of valve disc, in., measured after the sudden lift due to pop.

EDITORIAL COMMENT

Conserving Our Fuel Supply

Fuel is one of man's prime requisites. In so far as a country has abundance of fuel, therefore, it is economically more independent. Where there is a dearth of one kind of fuel, the endeavor has been to convert a fuel which exists in comparative abundance into that form for which there is a greater demand. Successful manufacture of oil from coal has recently been accomplished independently by several foreign chemists, who described their methods at the recent Conference on Bituminous Coal which was held in Pittsburgh.

Where, as in this country, coal is in abundance, its continued availability should be guarded by elimination of wasteful methods, of loose organization of mining properties, and of inefficient operation of mines. Waste of fuel has been common in this country and poorer classes of coal, together with culm and slack have generally been discarded for the best grades, which have been culled out. In the past, we had hoped that the gas producer would open up a new field for the consumption on a large scale of low-grade fuels; later our hopes were centered upon the pulverization of fuel to accomplish this purpose; may we not now look forward to the distillation of fuel oil and gasoline from our low-grade fuels as an efficient and timely solution to our problem?

In the Weekly Coal Report, No. 485, just issued by the Bureau of Mines, the large decrease in the number of operative mines during the years 1923-4-5 is forcibly brought out. It is noticeable that the mines that have survived are the larger ones, which may be taken to have the better organizations and controls, hence to operate the more efficiently.

We cannot, however, lightly regard the beneficial, stabilizing influence maintained by the presence of the "mushroom-like mines" that are ever ready to spring into action as soon as the price of coal has soared sufficiently high to warrant their functioning even under their characteristically less efficient operation.

Sound Business Ahead

From all agencies which analyze business conditions and study future probabilities comes the same report, that activity is likely to continue on a satisfactory basis, without slump or boom. Survey by the National Industrial Conference Board shows increasing stability as the outstanding characteristic of business development during the past 5 yr., due to improved methods of distribution, better organization of credit, and steadying influence of the Federal Reserve system.

More exact and more widely diffused information on business conditions have helped to better industrial and business management, due in considerable measure to work of business and technical journals, which has helped to level peaks and forestall panics.

Good labor conditions and prosperity of workers, such as now exist are held largely responsible for good business. Declining prices during the year have increased rather than diminished commercial activity and purchasing power of average weekly earnings is now 9 per cent higher than in 1920 and nearly 1 per cent higher than a year ago. Production and consumption have increased due in part to natural growth of population, while consumption of power has increased considerably faster than that. Distribution has kept pace with production so that even flow has been maintained from producer to consumer and no large stocks of goods have been accumulated.

In the major industries, steel shows some 10 per cent increase, production being the largest in history. Bituminous coal has increased some 43,000,000 t. Although anthracite, due to the strike, lost 40,000,000 t. it is now on a production rate nearly as large as for 1924 and has shipped mostly to domestic use. Workers in the metal industries have increased some 10 per cent. Electrical apparatus and machinery show good volume with increase in household equipment. Railway supplies are somewhat lagging, which is attributed to greater efficiency in handling of traffic by the railroads. In textiles, whims of fashion have reduced buying of cotton, woolen and silk fabrics, and foreign competition has affected the shoe industry, but indications seem to be that conditions in those industries will improve. Chemical products and paper and pulp have, during the year, shown substantial increases, which are likely to continue. Building shows some slackening, as the housing shortage has been abated, but the volume for replacement of old buildings is still large.

For all these lines, the outlook is for steady activity in volume as great as during 1926, which indicates that sound business is ahead.

The Right Kind of Public Ownership

Stockholders of the American Telephone and Telegraph Co. are said to now number in excess of 350,000. More than 65,000 stockholders are employes of the company or one of its associated corporations. No stockholder owns more than 2 per cent of all stock, and no group has control.

Many public utility companies, which but a few years ago were owned and controlled by a few thousand stockholders, are today owned and controlled by more than 2,000,000 stockholders. The United States Steel Co. has more than 150,000 stockholders, while the Standard Oil Companies have nearly one million.

It is healthy mental exercise to compare the earnings, efficiency, service and product prices of these concerns with those of government owned and controlled enterprises of similar character, wherever found. Judging from practice and not theory, the American brand of public ownership is the best.

Power Plant Development Number

JANUARY 1, 1927 ISSUE WILL BE AN ANALYSIS OF ENGINEERING PRACTICE AS EXEMPLIFIED IN IMPORTANT STEAM PLANTS RECENTLY CONSTRUCTED

FUNDAMENTAL changes in power plant equipment and conditions of operation have been going on rapidly during the past few years. The older methods of fuel handling and burning have given way to newer, more efficient methods and equipment in the efforts to avoid waste. Apparatus for the transfer of heat has undergone some quite radical changes. Liberties have been taken with the heat cycle that stood the test for several generations. Steam turbines have continued to grow in capacity and increase in efficiency. Electrical apparatus has been made safer, more reliable, more flexible and continuously more useful in the power plant.

To bring these changes forcibly to mind and to point out the trend of practice which is meeting with favor in the power plant field, the January 1, 1927 issue of Power Plant Engineering will contain a great amount of statistical data relative to the most important power plants of the country, which have been put into operation during the past 2 yr. This information will be analyzed to point out what constitutes the best practice in steam plant design at the present time.

Progress made in the process of combustion will be given careful consideration. Pulverized fuel has become permanently established in the power plant field. How it is prepared and burned in various plants, together with the essential features of the furnace design, will be fully described. Stokers and their furnaces have undergone changes which have made them more efficient and reliable and these will be pointed out in the January 1 issue.

Feed water is one of the raw materials used in the production of power and the most advanced methods of preparing it will be described. Purification, evaporation, deaeration, stage heating and heating in economizers all come under this general heading of Feed Water Systems.

During the past few years engineers have turned their attention to possible improvements in boiler design and operation and some quite radical changes are taking place. Steam pressures have increased from 300 and 400 lb. to 600 and 1200 lb. with corresponding temperature changes. Units of greater capacity have been demanded, requiring higher rates of heat transfer and increased furnace temperatures. Various elements of boilers, such as baffle and tube arrangements, superheater location and economizer element, have undergone changes in design.

In the field of superheating the tendency has been distinctly toward higher superheat. Effort has also been made to relate the superheating surface to the boiler heating surface in such a way as to give the best possible combination.

This has involved not only a study of the ratio of superheating surface to boiler heating surface, but also careful consideration of the location of the superheater in the path of the flue gases and the kind of superheater which can best be used.

Use of large boilers operated at many times their normal rating has also brought about a severe problem in the matter of furnaces and practice has been changing with regard to the volume, methods of baffling, the arrangement of arches, the kind and arrangement of refractories and the method of securing durability of furnace walls by air-cooling and by water-cooling.

Steam turbines have increased tremendously in size, presenting many problems and changes in conditions of operation, pressures and temperatures used, the control of steam, stage bleeding and design of blading to take advantage of high vacuums. The analysis of the statistics gathered for this issue will treat of all these problems.

Just as tube arrangement has been found to affect the efficiency of boilers, so has this feature of condensers been found of vital importance. The flow of steam in the condenser, water passes and velocity, the water-steam ratio, pump capacities, air removal, cooling surface, cleaning tubes and heads as practiced in the most efficient plants of the country will all be studied.

It is desirable to get the lowest possible vacuum; to do that, steam must be condensed rapidly and taken away from the exhaust of the prime mover as effectively as possible. It is desirable also to reclaim as large a part as possible of the heat carried from the prime mover by the exhaust.

Various methods are used, such as the heating of feed water by the exhaust steam, use of the condensate as boiler feed and, in some instances, reclaiming of heat from the cooling water.

With modern low vacuum, however, the temperature of the exhaust steam is so low that the condensate is more likely to be used as a cooling medium for oil and bearings, thus carrying back to the boiler in the condensate some of the heat that otherwise would be wasted around the plant.

Electric generators have kept pace with turbines both in capacity and speed. Conditions of load placed upon them have necessitated changes in design and these features will be pointed out in the section devoted to this class of equipment.

From the generators to the transmission lines, the electricity must be under absolute control and the changes in methods practiced during the past few years have affected generator connections, transformers, bus systems, feeder systems and substations, all of which will be treated in this number.

By surveying carefully the progress in central station development and the adaptation of central station features to industrial plants, it is possible to determine to what extent other plants may well be altered and modernized, and whether the time has come to drop old systems and methods and put in new apparatus.

In recent years, progress has been continuous and rapid, but the effective use of the heat cycle has now reached the point where careful study of small details is essential in order that further progress may be made.

The January 1, 1927 Specialized Number of Power Plant Engineering is a contribution to this careful study, so that engineers may more fully visualize the direction in which future progress is possible and probable.

Opportunity Awaits Engineers

GRAND CENTRAL PALACE, N. Y., WILL BE A CENTER OF ATTRACTION FOR POWER PLANT MEN DURING POWER SHOW WEEK

LATEST and best developments in power equipment for generating plant, transmission and the use of power will be found here.

In the exhibits on the four floors, everything needed by the power plant engineer will be displayed and demonstrated, from lamps, wire and fittings to turbine-generators, boilers and stokers. The engineer who thoughtfully studies the exhibits will carry away a fund of knowledge about equipment and its possibilities which will serve him well in planning future construction, extensions, replacements and operation.

Arrangement of the booths and their numbers is shown on the floor plans herewith and the directory gives complete information as to where the exhibit of any company is to be found and what it contains.

It will help in the use of this list to remember that booths from 1 to 101 are on the first floor, those from 2 to 28 being around the walls. Numbers 30 to 42 are near the 47th Street side, 46 to 73 run through the central part of the floor from the main entrance. Nos. 74 to 94 are near the 46th Street side, No. 95 is near 14 and 99 to 101 are on the 47th Street side near No. 8.

Booths 201 to 347 are on the second or mezzanine floor, 201 to 259 being wall booths, 260 to 282 on the 46th Street side, 283 to 331 along Lexington Avenue and around the elevators, 332 to 347 on the 47th Street side. On the third floor are booths 401 to 569. Numbers 401 to 461 are around the walls, 462 to 529 surround the open court, 530 to 569 are arranged around the elevators and stairs.

Numbers 601 to 773 are on the fourth floor, 601 to 643, also 692 and 693 being around the walls, 646 to 733 are in a block near the conference room, 734 to 773 are around the elevators.

On the fourth floor is the conference room, where a series of motion pictures will be exhibited during the show. This list will include the following:

The Story of Brass and Copper, Mueller Brass Co., 3 reels; The 20th Century Woodworker, 20th Century Woodworker Co., 1 reel; Oxygen: The Wonder Worker, Air-Reduction Sales Co., 4 reels; Fighting Furnace Failures, Plibrico Jointless Firebrick Co., 2 reels; The Manufacture of Genuine Wrought Iron Pipe, A. M. Byers Co., 4 reels; The Fall of Man, National Safety Council and Tri-Lok Co., 2 reels; The King of the Rails, 3 reels, The Electrical Giant, 1 reel, The Queen of the Waves, 2 reels, Anthracite Coal, 1 reel, Bituminous Coal, 1 reel, General Electric Co.; The Story of Asbestos, Johns-Manville, Inc., and U. S. Bureau of Mines, 3 reels; The Story of Abrasives, Carborundum Co. and U. S. Bureau of Mines, 4 reels; Water Power, 2 reels; Transportation, 2 reels, Westinghouse Electric & Mfg. Co. and U. S. Bureau of Mines; Saving Coal at Home, 1 reel, The Story of Steel, 6 reels, The Story of Alloy Steel, 4 reels, The Story of Power, 3 reels, U. S. Bureau of Mines.

Times of exhibit of these reels can be found from the daily bulletins or at their booths from the companies who furnish them.

Grand Central Palace, where the exhibits will be found, is on Lexington avenue between 46th and 47th streets. It is within easy walking distance of the Grand Central R. R. station and can be reached quickly by the east side elevated or subway lines or the Lexington avenue surface line.

All exhibits are worth study, but, for those whose time is limited, the directory gives the means of planning to see the displays which are of chief interest to them.

Power Plant Engineering, in Booth 99 on the main floor, will be at the service of visitors at all times to furnish information and assist in making appointments.

ACCURATE BRASS CASTING CO. INC. — Booth 465
Brass and copper forgings and castings to close dimensions and the method of making them.
Representative:—Charles M. Rose, sales manager.

ACKERMAN-JOHNSON CO. — Booth 423
Steam specialties and power plant accessories.
Representative:—W. A. Stone.

ACORN MANUFACTURING CO. — Booth 768
Load Indicator and communication systems.
Representatives:—F. F. Elznic, sales manager; S. N. Mead, chief engineer.

ADVANCE ENGINEERING CO. — Booth 274
Steam traps for high pressure and superheat, Craig system of combustion control.
Representatives:—Charles W. Gill, C. Wilson Gill, Robert Bristow, Roger Farr.

AERO PULVERIZER CO. — Booths 319-20
Aero unit coal pulverizer and parts after long service.
Representatives:—W. L. Martwick, F. D. Seymour, G. Parsons West, Arno N. Dietze, H. B. Baird.

AHLBERG BEARING CO. — Booth 693
Details of bearings and their applications.
Representatives:—F. O. Burkholder, sales manager; H. E. Dunning, district sales manager; R. E. Bender, New York branch manager; J. E. Butler.

AIR PREHEATER CORP. — Booths 234-5
Ljungstrom air preheater and Howden air compressors. Forced draft apparatus and patented furnace.
Representative:—C. A. Jacobson.

AIR REDUCTION SALES CO. — Booth 474
Airco Davis-Bournonville hand welding and cutting apparatus, Airco oxygen and acetylene cylinders, and welding supplies.
Representatives:—W. S. Schoenthaler, Metropolitan district manager; Frank Morton, B. F. Shaeffer, W. I. Lebaugh, E. S. Grace, H. G. Fay, Metropolitan district representatives.

AJAX FLEXIBLE COUPLING CO. — Booth 462
Ajax couplings in a full line, and for all coupling purposes.
Representatives:—W. T. Welch, president; W. P. Oakes, secretary and treasurer; M. A. Bornand.

ALEXANDER BROS. — Booth 422
Tentacular belt in operation on a motor-driven blower with short centers and high pulley ratio to show efficiency of transmission.
Representatives:—J. L. de Rabot, consulting engineer; J. Allan Machin, L. P. Yerkes, W. L. Fort, Edward B. Rogers.

A. ALLEN & SON — Booths 483-4
Applications of Allan red metal, for labyrinth packing rings for steam turbines, for piston rod and valve stem packing rings and for facing pistons for steam engines, air compressors and pumps.
Representatives:—Andrew Allan, William T. Allan, H. D. Chandler, Henry Chandler.

ALLAN & BILLMYRE CO. INC. — Booths 491-2
Pneumatic sweeping and cleaning system for use in power plants, industrial plants and institutional buildings. These will be shown in heavy stationary form, in heavy duty portable form and in light portable form.
Representatives:—F. C. Allen, Jr., J. F. Billmyre, Edward N. Burns, H. V. Conrad, R. J. Heller, W. A. York, O. S. Lieberg, I. H. Russell, E. Failmezger.

THE ALLEN-SHERMAN-HOFF CO. — Booth 75
Hydrojet system of ash conveying, and gates for handling ashes. Cast-iron coal bunker and accessories.
Representatives:—D. W. Simler, J. T. Deutsch, F. B. Allen.

ALLIS-CHALMERS MFG. CO. Booths 516-17

Reyrolle Armorclad Switchgear in operation, combining in one unit busbar construction, circuit breaker, feeder connections and instrument transformers. Induction motors equipped with Timken Roller bearings, enclosed self-ventilating motor, Texrope drive for short centers, models of hydraulic turbine runners for high and low heads, contrifugal pumps, and industrial machinery.

Representatives:—A. E. Rolf, manager, New York office; H. W. Dennision, A. J. Cooper, H. C. Hall, F. J. Geiger, R. H. James, C. A. Pihl, George Baiz, W. O. Taylor, S. Larios, L. M. Littmann, D. M. Weller, F. M. Decker, New York office.

ALSOP ENGINEERING CO. Booth 212

Mixing machinery and portable pumps.

Representatives:—S. Alsop, Charles Crawley.

AMERICAN ABRASIVE METALS CO. Booth 605

Feralun antislip tread, cast iron with emery surface, for stairs, floors, trench covers. Also Bronzalun treads with bronze base and alumalun with aluminum base, the last for salt water conditions.

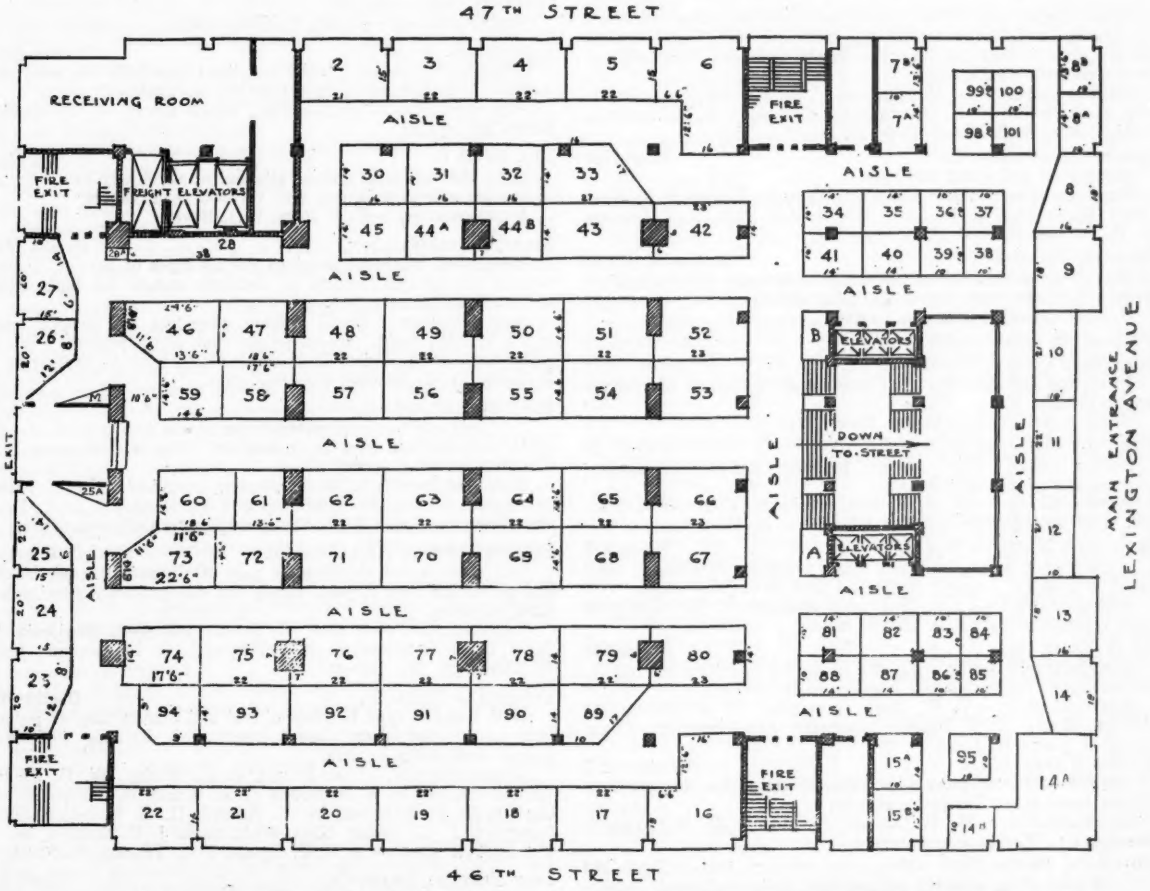


FIG. 1. BOOTHS 2 TO 101, ALSO A, B AND M WILL BE FOUND ON THE FIRST FLOOR

Representatives:—Ellsworth Burger, H. W. Mowery, S. C. Sherwood, C. A. Cocks, G. W. Cameron, R. B. Eastty.

AMERICAN AIR COOLED BLOCK ARCH COMBUSTION CO. Booth 665

Air cooled side walls, suspended block arches, and furnace construction for various types of boilers.

AMERICAN ARCH CO. INC. Booth 58

Arches of suspended type with pressed steel clips carrying the suspended and interlocking pillar tiles.

Representatives:—J. A. Lodwick, general manager industrial department; H. A. Mannshardt, F. D. Hazen, M. V. Kay, R. G. Strever, W. B. Tardy, E. Smiley, J. J. Tyrrell, F. M. Willett, K. H. Woolson.

AMERICAN BLOWER CO. Booths 231-2

American blower dry air filter in unit cell form.

Representatives:—F. R. Still, vice-president and secretary; Arthur Ritter, T. L. Kennedy, A. Steinmetz, Benjamin Adams, J. W. Brinton, E. F. Falk, J. F. Munder, J. A. Nichols, T. J. Oliver.

AMERICAN CAR & FDRY. CO. Booth 203

Berwick electric heaters for heating rivets and for heating forgings for upsetting or forging work, also a miniature model in operation demonstrating the action of the bar heater.

Representatives:—F. C. Cheston, sales agent; W. M. Earle.

AMERICAN FOUNDRY & EQUIPMENT CO. Booth 679

Special castings for high pressures and temperatures.

AMERICAN HOIST AND DERRICK CO. Booth 515

Steam, electric, and gasoline hoists, cranes for the storage and reclaiming of coal.

AMERICAN MACHINE & FDRY. CO. Booths 424-7

Included in this exhibit will be the Automatic Weighing Machine Co. with apron feed and automatic sacking scales, the pump department with rotary, high speed, direct drive pumps, wrapping machine department for packaging material and the Wahlstrom Tool Co. with automatic tapping devices.

Representatives:—Harry Woodall, William Cooper, William McKelvie, automatic weighing machine division; C. Q. Wright Jr., C. E. Anderson, pump department; R. E. Wells, D. M. Fincke, T. F. DuPuy, T. R. Stevens, wrapping machine division; S. F. Chalfin, Havelock Walser, Wahlstrom Tool Co.

AMERICAN PIPE BENDING CO. Booth 770

Pipe bending machines in operation for making cold pipe bends.

Representatives:—E. P. Blake, sales manager; Charles G. Percival.

AMERICAN PULLEY CO. Booths 547-8

Transmission equipment, including split belt pulleys, pressed steel shaft hangers, shift or arm attachments and other pressed steel products.

AMERICAN PULVERIZER CO. Booth 617

Model to ¼ in. scale, of American Ring Crusher in operation.

Representatives:—Paul S. Knittel, New York office; Ernest E. Lee, Charles Hardin, Chicago office.

AMERICAN SCHAEFFER & BUDENBERG CORP. Booth 74

Indicating and recording gages and thermometers, tachometers, steam traps, gage testers, safety and water relief valves, control apparatus for pressure, temperature and humidity.

Representatives:—G. A. Binz, sales manager; A. E. Campbell, W.I. Stark, F. Undeutsch, A. J. Nelson.

THE AMERICAN WELLS WORKS Booth 662

Centrifugal pumps of multiple stage split shell type and of belt-driven solid shell type, also working model of two-stroke deep well plunger pump, deep well cylinders, and standard Underwriter's fire pump.

Representatives:—R. W. Ruth, G. H. Gaus, F. C. Hastings, E. E. Brereton, H. L. Schwartz, and F. W. DuBois.

B. C. AMES Co. Booth 646

Bench lathe, milling machine, combination lathe, milling machine and drill press and micrometer dial gages.

Representatives:—John Cetrule, Nicholas Cetrule, P. Seibel.

AMES SHOVEL AND TOOL Co. Booth 528

Shovels and scoops, heat treated to resist abrasion and distortion.

Representative:—J. C. Walker.

ANACONDA COPPER MINING Co. AND AMERICAN BRASS Co. Booth 65

Brass, copper and nickel silver materials, including condenser tubes, steam and hot water tubing, rods and bars, Tobin bronze piston rods and shafting, bare and insulated copper wire and bus bars, Anaconda welding rods.

Representatives:—G. M. Hurlbut, C. A. Powles, F. F. Thursfield, L. B. Smith, H. B. Dwenger, D. A. Parker, H. A. Buckbee, T. M. Baker, A. C. Risedorf, W. H. Dowd.

ANDALE ENGINEERING Co. Booth 564

Duplex oil and water strainers.

Representatives:—Anderson Mac Phee, D. Raymond McNeal, James M. Jenkins, C. R. Lind, Gilbert Mac Phee, J. T. Gordon, M. E. Durkee.

ANDREWS-BRADSHAW Co. Booths 17, 189-90

Tracyfier for removal of suspended matter and impurities from steam before the steam leaves the boiler drum.

Representative:—J. Lucien Jones.

ANTHRACITE COAL SERVICE Booths 636-9

ARMSTRONG CORK & INSULATION Co. Booths 344-5

Insulating materials for high temperature lines and for refrigeration lines.

Representative:—Mr. Fenter, New York.

THE ASHTON VALVE Co. Booth 38

Safety valves, relief valves, pressure and vacuum gages, whistles and gage testing outfits.

Representatives:—H. H. Ashton, president; Chas. W. Buckelew, New York manager; Chas. W. Ulrick, H. W. Rand.

ARMSTRONG MACHINE WORKS Booth 275

Glass trap in operation under steam pressure, Armstrong compound trap and a complete line of all sizes of regular traps.

Representatives:—L. D. Goff, sales manager; C. W. Gill, New York representative; O. E. Ulrich, traveling representative.

ATLAS VALVE Co. Booth 635

Campbell feed water regulator in actual operation at 100 lb. pressure, showing the special features of the system.

Representatives:—V. F. Davis, president; F. H. Davis, Jr., vice president; L. J. Siggins, secretary and treasurer; Grant Campbell, Louis H. Dietz.

ATWOOD & MORRILL Co. Booths 562-3

Turbine and condenser valves, special valves for low pressure bleeder heating and damper regulator.

Representatives:—H. E. Morrill, president; B. T. Atwood, treasurer; C. T. Atwood, secretary.

AUTOMATIC PRIMER Co. Booth 244

Alco primer for creating suction vacuum in horizontal centrifugal pumps without foot valves. Sump pump equipment.

Representative:—F. H. Bradford, president.

BABCOCK & WILCOX Co. Booth 51

Details of B. & W. boilers and superheaters, also of chain grate stokers.

E. B. BADGER & SONS Co. Booth 436

Expansion joints, with self-equalizing, corrugated elements. Non-clog spray nozzles and arrangement in cooling ponds.

Representatives:—Harold W. Coombs, Frederick R. Heath, Frank E. Lyons, Charles E. Greene.

BAILEY METER Co. Booth 51

Meter panel boards, Bailey boiler meters, fluid meters, pressure and temperature recorders, multi-pointer gages and a demonstration of the effect of pipe fittings upon the flow of fluids. Bailey automatic meter control for fuel and air supply.

Representatives:—E. G. Bailey, president; H. M. Hammond, sales manager; R. S. Coffin, L. W. Heller, C. R. McClure, H. C. Tanner, H. C. Wheaton.

THE BALDWIN CHAIN & MFG. Co. Booth 760

Working exhibit of steel roller chain and precision silent chain running on sprockets in a special exhibition frame.

Representative:—A. W. Warren, sales manager.

THE BALLWOOD Co. Booth 214

Pipe fabrication, consisting of forged hammer welded flanged piping, reinforced square corner Van Stone joints, and Van Stone joints of seamless steel in sizes ¾ to 6-in. for 600 lb. pressure.

Representatives:—George A. Williams, A. H. Dirk, E. J. Hughes.

BARCO MANUFACTURING Co. Booth 545

Barco lubricated and balanced plug valves, Barco flexible joints.

Representatives:—A. S. Lewis, R. P. Klein.

BARNES & JONES Booths 312-13

Details of modulation, vapor and vacuum heating systems, also traps and valves for steam and water heating systems and for radiators.

Representatives:—Walter E. Barnes, William T. Jones, Henry B. Eels, Nelson A. Emmons.

BASSICK MFG. Co. Booths 480-1

Alemite forced grease lubricating system for application under extremely high pressures.

Representatives:—J. Guy Griffith, Walter N. Duncan.

BARTLETT-HAYWARD Co. Booths 344-5

Shaft couplings and special couplings especially for steel mill service. Photographs of representative installations.

Representatives:—Gustave Fast, Hugh Benet, H. W. Calder, James M. Jenkins.

THE BAYER Co. Booths 346-7

Soot blowers, with special attachment to blower head for air circulation when not in use, also valve-in-head control.

Representatives:—F. P. Rose, L. J. Bayer.

BEARIUM BEARINGS, INC. Booths 524-8

Rough and machined bearings for all types of service, demonstrating the special features of Bearium metals for high speeds without lubrication.

Representatives:—H. G. Pagani, president and general manager; W. H. Judy, vice president and chief engineer; F. A. Robertson, vice president in charge of sales; A. A. Matthews, J. W. Haig, H. R. Johnson, sales engineers.

R. H. BEAUMONT Co. Booth 50

Coal and ash handling system from car to bunker or to storage field, from storage field to bunker and from bunker to stokers. Complete working model.

Representatives:—R. H. Beaumont, president; E. A. Thumlert, secretary; H. W. Ruth, New York manager; J. A. Beck, advertising manager; L. G. Weygandt, eastern sales manager.

BERNITZ FURNACE APPLIANCE Co. Booth 78

Full sized layout showing the uses of Carbofrax super blocks, and pulverized fuel furnace lining, for the construction of power plant furnaces.

Representatives:—Arthur E. Smith, manager; Benjamin H. Snow, C. H. Schroder, E. R. Jefferson, L. R. Leatherman, J. M. Nicholson, H. W. Jarrett.

BETHLEHEM STEEL Co. Booths 70-1

New roll tire type Bethlehem fuel and mineral matter pulverizer. Also Bethlehem Diesel engine, oil burning equipment, pumps, feed water heaters.

Representatives:—J. B. Briggs, G. L. Wodey, W. E. Dickey, Thomas Service, F. K. Steinrock, G. A. Worm, H. Thomas, C. H. Garlick, C. D. Hubbard, W. E. Newell, H. B. Davidson, G. E. Lawrence, J. C. Tobias, G. A. Richardson, J. P. Madden, W. F. Price, O. A. Kreutzberg, R. T. Dynan, P. C. Tennant, R. F. Lloyd.

BIAX FLEXIBLE SHAFT Co. Booth 757

Special applications of the Biax flexible shaft to machines used in manufacturing industries.

Representatives:—R. Wezel, G. M. VanderBeek, F. I. VanderBeek.

THE BIGELOW Co. Booth 68

Drawings and photographs of the various types of Bigelow boilers, including the return tubular, two pass, Manning and the electric steam generator. Also working model of the Bigelow-Hornsby boiler.

Representatives:—G. S. Barnum, president; S. H. Barnum, vice president; G. Welter, chief engineer; T. C. Vincent, George Dahm, P. M. Fleming, sales engineers.

L. C. BIGLOW & Co. INC. Booth 752

Ganschow planetary speed transformer and Ganschow worm gear reducer, Scully-Jones "Wear-Ever" production tools.

Representative:—L. C. Biglow, president.

BLACKBURN-SMITH CORP. Booths 244-5

Feed water filters and grease extractors, multiduct strainer for trash removal, Michaels automatic drain valve for removing condensation from cylinders, Apco automatic primer for horizontal centrifugal pumps, Hart force sight feed oil pumps.

Representative:—I. H. Kaufman.

BOIG & HILL, INC. Booth 10-A
Pressure and damper regulators, steam traps and temperature regulators of the Curtis brand.
Representative:—Messrs. Herrick and Bezonson of the Julian d'Este Co.; William T. Hill, Joseph Meyer, of Boig and Hill.

BOILER ENGINEERING CO. Booth 450
Section of Beco baffle wall, showing the details of design and construction.
Representatives:—J. W. Putnam, vice president; Frank Beers, E. Hammond.

BOSTON GEAR WORKS SALES CO. Booths 340-1
Speed reduction units, hardened and ground spur gears and Boston silent chains.
Representatives:—H. H. Kerr, H. C. Woodcom, H. Muller.

BOTFIELD REFRACTORIES CO. Booth 546
Demonstration of the properties of and construction possible with Adamant fire brick cement and the holding power of the single ring arch built with this cement.
Representatives:—L. B. Botfield, Axel H. Engstrom, sales manager; Chas. C. Phillips, district manager for New York; W. B. Smith, refractories engineer; A. J. Wittwer, Joseph J. Sweeney.

S. F. BOWSER & CO., INC. Booth 739
Complete systems of lubrication, oil filtration and oil storage.
Representative:—C. H. Bromley.

BRADLEY WASHFOUNTAIN CO. Booth 247
Washroom equipment for sanitary installation, 54-in. foot controlled water supply.
Representatives:—A. C. Cooper, T. W. Higgins, W. H. Silpoth, sales manager.

THE BRISTOL CO. Booth 12
Complete line of recording instruments for pressure, vacuum, temperature, water level and electrical voltmeters, ammeters and wattmeters.
Representative:—L. G. Bean, Chicago district manager.

THE BROWN INSTRUMENT CO. Booth 34
Induction-bridge-principle electric flow meter, indicating and recording instruments with circular and strip chart records, CO_2 meter for boiler front or switch board, with strip chart having single, duplex and multiple records, pyrometers, thermometers and other indicating and recording instruments.
Representatives:—J. P. Goheen, secretary; G. W. Keller, J. D. Andrews, George Goodman, R. F. Roberts, K. R. Knoblauch, George Beck, L. M. Morley, R. B. McCafferty.

BUFFALO FORGE CO. Booth 73
Mechanical draft apparatus for forced and induced draft, for stoker fired and pulverized fuel plants. Ventilating fans and system of generator cooling.
Representatives:—C. A. Booth, vice president and general sales manager; F. B. Stubinger, advertising manager; O. S. Ryan, service department; R. W. Pryor, W. S. Koithan, New York office.

BUFFALO STEAM PUMP CO. Booth 73
Centrifugal pumps in multi-stage and single stage with single and double suction. Special forms of single stage pumps for high head.
Representatives:—C. A. Booth, vice president and general sales manager; F. B. Stubinger, advertising manager; O. S. Ryan service department; R. W. Pryor, W. S. Koithan, New York office.

BUILDERS IRON FOUNDRY Booth 277
Venturi meters for measurement of feed water, condensate and cooling water, in registering, indicating and recording form, also radial planimeter for obtaining totals from Venturi charts.
Representatives—D. J. Purdie, manager New York office; E. S. Smith, Jr., assistant designing engineer; A. A. Wood, manager Philadelphia office; F. A. Merlo, assistant New York office; H. J. Leonard, service.

BUNDY STEAM TRAP CO. Booth 8
Complete line of steam traps for typical power plant conditions and demonstration of improvements in Bundy equipment.
Representatives:—E. M. Stevens, vice president and sales manager; W. W. Booth, New York representative; D. J. Stump, Boston representative; Jesse Owens, Elmira representative; L. E. Reed, Wooster-Springfield, Ohio; Charles W. H. Hebert, chief engineer and plant superintendent.

EDWIN BURHORN CO. Booth A
Working model of cooling tower and details of construction of full sized cooling surface and louver construction with photographs of installations.
Representatives:—Edwin Burhorn, president; Chas. A. Harry, William Hennings, Henry A. Stover, Jr., G. G. Harrison, Carl Dahlquist.

A. M. BYERS CO. Booth 429
Byers genuine wrought iron pipe, methods of manufacture, and qualities as proved by tests and by installations.

ANDREW C. CAMPBELL Booth 660
Various types of nibbling machines in operation for the shaping of sheet metal from 1/16 in. up to ⅜ in. thickness.
Representatives:—J. Johnson, Stuart Naramore.

THE CARBORUNDUM CO. Booth 22
Carborundum and Aloxite refractory shapes and cements for high temperature furnaces of all kinds. Also the Carboradiant chamber for application of heat by radiation, burning oil, gas or powdered fuel.
Representatives:—C. E. Hawke, sales manager; S. A. Fenno, assistant sales manager; J. A. King, New England sales representative; J. G. Fritzinger, sales representative, Maryland, Pennsylvania and Virginia; F. W. Miller, New York sales representative.

CARRICK ENGINEERING CO. Booth 264
Furnace regulators, chronometer valves and mercury actuated master control for furnace operation.
Representatives:—G. S. Carrick, John H. Hillmeyer, L. R. Merritt, R. B. Kleinert.

CARRIER ENGINEERING CO. Booths 14A-14B
Heating and ventilating equipment with air conditioning apparatus and generator cooling systems.
Representative:—W. H. Carrier.

THE CASEY-HEDGES CO. Booth 504
Photographs and working model of the various types of boilers showing various types of construction.
Representatives:—Messrs. Rowland, Burns, Rindge, L. H. McGowan.

A. W. CASH CO. Booth 276
Craig system of combustion control and models of pressure regulating devices.
Representatives:—C. W. Court, V. A. McKechnie.

CELITE PRODUCTS CO. Booth 14
Methods of furnace construction and of installing insulation, display of Sil-O-Cel brick, block, powder and cement, and of Celcote air-sealing compound and Fraxite refractory cement.
Representatives:—E. S. Crosby, general sales manager; Fred H. Emerson, divisional sales manager; W. D. Van Arnam, assistant; P. R. Deschers, L. E. Putnam, L. R. Mays, sales engineers.

THE CENTRIFIX CORP. Booths 302-3
Centrifugal separation of steam, air, gases, vapors and liquids.
Representatives:—C. G. Hawley, F. J. Crolius, J. A. Boyden, O. P. Warner, L. C. Kerner.

THE CHAPMAN VALVE MFG. CO. Booth 2
Chrome steel gate valves and fittings, for high pressure and temperature, the Chapman motor unit for valve operation as a working demonstration, iron body gate valves for water and steam service, and representative brass valves for general service, results of research work on bolt failure and the suggested remedy.
Representatives:—Frank C. Shannon, C. H. Maher.

CHICAGO PIPETHREAD MACHINE CO. Booth 443
Power pipe-thread machine with automatic opening head, three speeds, and high speed steel dies, constructed for high production or for portable use.
Representatives:—Leslie H. Taylor, president; R. T. Ingalls, secretary; Clifford Peterson, treasurer.

CHICAGO WILCOX MFG. CO. Booth 274
U-shaped metal gaskets with filling of asbestos, rubber or leather.

CLARAGE FAN CO. Booths 468-9
Air washers, multiblade fan for ventilating work, high-speed forced draft fans, exhaust fans, special steam engine for driving stokers, fans and pumps, blast gates, dampers and exhaust fans for powdered coal systems.
Representatives:—Charles Clarage, president; L. O. Monroe, general manager; P. V. Smith, manager, New York office; Robert Wasson, New York office.

CLEVELAND WORM & GEAR CO. Booth 92
Speed reducting units of worm gear type with motor drive.
Representatives:—Howard Dingle, vice president and general manager; J. T. Gordon, M. E. Durkee, New York office.

CLIPPER BELT LACER CO. Booth 551
Belt lacers, belt cutters, plain and rust-proof belt hooks, connecting pins, moving belt display.
Representatives:—Edward R. Dawson, William F. Kall.

COCHRANE CORP. Booth 67
Cochrane products for steam handling, including a deaerating heater, strainerless conical filter with single control valve, flow meter of indicating, recording and integrating type, multiport back pressure valve, steam or oil separator for horizontal pipe and for vertical pipe, high-pressure trap of bucket type, multiport drainer or low-pressure trap with balanced valve.
Representatives:—J. S. L. Wharton, president; J. C. Jones, treasurer and general manager; H. E. Sibson, vice president and general sales manager; A. B. Wallen, secretary and general works

manager; P. S. Lyon, chief engineer; G. H. Gibson, consulting engineer; J. B. Fowler, chief inspector; J. E. Harris, sales department; J. D. Yoder, A. Drescher, softener department; Chas. Wharton, production department; J. S. L. Wharton, Jr., inspection department; F. E. Idell, W. W. Montalvo, F. B. Sage, A. R. Foote, New York office.

THE COEN CO. Booth 15B

Oil burning equipment including burners, registers, oil heaters and so forth.

Representative:—F. F. Harper.

COFFIN VALVE CO. Booths 409-10

Motor drive unit for gate valve and solenoid controls for pivot valves and hydraulic cylinders.

Representatives:—Donald M. Belcher, general manager; Charles R. Kelty, superintendent.

COMBUSTION ENGINEERING CORP. Booths 23-25

Lopulco pulverized fuel burners and feeders, Couch burner for horizontal firing, Raymond pulverizer, C-E unit system pulverizing mill, fin furnace and air heater, Coxe stoker and Green forced-draft stoker. Motion displays of Lopulco system and the Combustion steam generator. Details of Ladd boiler.

Representatives:—R. C. Beadle, Charles McDonough.

COMBUSTION SALES CO. Booth 643

CONNERY & CO. Booth 43

Air-cooled damper construction and wagon top breaching with expansion stiffener for breaching and air preheater ducts.

Representatives:—Wm. M. Connery, C. B. Nicholson, A. D. Stewart, W. J. Henderson, W. E. Gaunt.

CONSOLIDATION COAL CO. Booth 463

Coal mining and preparation and samples of the coal which the company markets, displayed by moving picture films.

Representatives:—W. D. Barrington, F. Van O'Linda, H. A. Damcke, J. D. Woodson, G. F. Corlis, E. P. Collins.

CONTINENTAL VALVE & EQUIPMENT CO. Booth 316

Forged steel pipe fittings, flange unions, box unions and pump governors of special design and construction for high pressures, superheated steam and for hydraulic and refrigeration service.

Representatives:—Wm. T. Shea, Olaf E. Oleson.

COOLING TOWER CO. Booth 523

Air filters, spray nozzles, air washers and models of cooling towers.

Representatives:—A. B. Tappen, president; L. A. Phillips, vice president; J. H. Taylor, secretary; B. H. Coffey, consulting engineer; E. C. Sickles, engineer; A. A. Morse, advertising manager.

COOPER-HEWITT ELECTRIC CO. Booths 698-9

Industrial lighting systems.

Representatives:—Chas. F. Strebig, sales manager; D. R. Grandy, commercial engineer; H. M. Ferree, illuminating engineer; R. D. Mailey, chief engineer and factory manager; Geo. Millar, factory superintendent; J. P. O'Shea, A. W. Willmann, W. C. Hubbard, F. M. Haviland, sales engineers.

CORK FOUNDATION CO. Booth 761

Absorbo cork foundation mats for absorbing vibration of all types of machinery.

Representatives:—W. S. Timmis, J. W. Clissold, William Karl, Dore Sundland.

CHAS. CORY & SON, INC. Booths 241-2

Signaling, communicating, lighting, control and protective devices, flexible metal hose and other central station equipment for control of the operation of power plants.

Representatives:—J. S. Jones, vice president; L. E. Oneal, manager industrial dep't; A. D. Blanchard, manager metal hose dep't; G. B. Thieme, M. I. Warshaw, J. B. Feder, engineers; district managers: R. L. Reaves, Philadelphia; H. D'Almaine, Chicago; A. E. Sargent, Boston; C. G. Lamb, Detroit; Walter B. Tardy, Baltimore; A. A. Kopp.

CRANE CO. Booth 52

Cast steel gate valves for pressures up to 900 lb., forged steel gate and globe valves with trimmings of stainless steel, receiver type steam separators of all-steel construction with welded joints.

Representatives:—M. W. Link, M. Baxter, G. E. Barker, W. E. Allen, T. H. Ireland.

CROSBY STEAM GAGE & VALVE CO. Booth 98

Nickeloy Globe valves, monel and steel valves for pressures up to 900 lb. and gage-testing machine for pressures up to 25,000 lb.

Representatives:—George F. Jelker, president; L. W. Lenderolph.

CURTIS & CURTIS CO. Booth 472

Pipe Cutting and threading machinery in various types and with accessories.

THE CUTTER ELECTRICAL & MFG. CO. Booth 14-B

Large I-T-E carbon circuit breaker for 4000 amp. at 440 v. and a line of U-Re-Lite breakers enclosed in steel box for 230-v., d.c. and 550-v., a.c.

Representatives:—E. Swift Newton, vice-president; W. C. Jessup, M. B. Cutting, R. C. Heyl.

THE DAMPNEY CO. OF AMERICA Booth 248

Apexior, corrosion-preventing coatings for power plant equipment and power-operated brush equipment for the application of coating to water-tube boiler tubes.

Representatives:—E. Fenton Gilbert, president; Charles F. Moore, vice-president; T. H. Burch, Jr., P. L. Rhodes, New York; C. J. Hunter, Philadelphia; B. M. Herr, Pittsburgh.

M. T. DAVIDSON CO. Booths 36-7

Working models of steam and centrifugal pumps.

Representatives:—John Lowe, W. C. Brennan, H. A. Prindle, T. J. Rogers.

DAVIS ENGINEERING CORP. Booths 415-16

Paracoil steam specialties, including feed water heaters, oil heaters, filters and grease extractors, waste heat boilers and steam traps.

Representatives:—H. C. Davis, W. H. Thompson, C. G. Smith, R. W. Brown, A. O. Jaeckel.

G. M. DAVIS REGULATOR CO. Booth 267

Pressure regulating valves, relief valves, nonreturn valves, float valves and float boxes for control of make-up, stage heater traps and traps for condensate, balanced valves for heater make-up control, disk nonreturn valves for service where no drop in pressure is desired across the valve.

Representatives:—Geo. C. Davis, H. A. Freeman.

DEARBORN CHEMICAL CO. Booth 13

NO-Ox-Id rust preventive and moving pictures of the laboratory and manufacturing plant of the company illustrating its methods of feed water treatment.

Representatives:—Grant W. Spear, W. H. Kinney, T. H. Platt, J. E. Harris, Geo. W. Carr, Frederick W. Tibbetts, Stacy H. Opdyke, John J. Spence.

THE DE LAVAL SEPARATOR CO. Booths 536-43

Crank case oil reclaiming outfit, portable transformer oil outfits and oil purifier outfits.

Representatives:—P. F. Miller, S. W. Moss, W. D. Cleary, J. H. Lisle, D. F. Miller, C. B. Bower, A. J. Marron, R. L. Smith.

DE LAVAL STEAM TURBINE CO. Booths 536-43

Worm gear drives for speed reduction and speed increase, showing all the details of construction. Helical gears for speeding up or speeding down. A complete motor-driven pump test, pin and rubber bushing type flexible couplings, a sectioned velocity stage steam turbine, turbine rotor for multi-stage turbine, and other details of De Laval apparatus.

Representatives:—F. W. Kennedy, vice-president and general manager; H. L. Watson, sales manager; C. R. Waller, chief engineer; A. Petersen, assistant chief engineer; J. W. Hertzler, manager worm gear department; L. W. Frisbee, sales engineer; Mr. Wills, sales department; Messrs. Clem, Haden, J. S. Beck, New York office.

JULIAN D'ESTE CO. Booth 10

Curtis engineering specialties, including pressure regulators, combustion controls, and traps.

Representatives:—Daniel A. Herrick, George Bezonson, Boston office; Wm. T. Hill, Joseph Meyer, New York office.

M. H. DETRICK CO. Booth 94

Sectionally-supported side walls for pulverized fuel furnaces and Detrick flat suspended arch.

Representatives:—R. D. Foltz, W. A. Hanke, W. A. Vidro, W. M. Ehrlich.

DETROIT STOKER CO. Booths 204-6

Full size underfeed stokers in operation and worm gear drive for stokers with control of stroke of the pusher rod.

Representatives:—W. H. Rea, president; W. H. Riecks, secretary and works manager Monroe plant. R. L. Beers, chief engineer; F. B. Strale, director of sales; H. B. Post, New York manager; W. L. Higgins, New York office; H. W. Maitland, service department; E. L. Beckwith, Chicago; L. I. Snodgrass, Cincinnati; J. M. Keylor, Philadelphia; Fred Willins, Cleveland; Robert June, publicity director.

DE WALT PRODUCTS INC. Booth 607X

DIAMOND POWER SPECIALTY CORP. Booth 16

Miniature boiler with application of soot blowers to show correct principles and effects of soot deposits in retarding heat transmission. Motion picture films from the U. S. Navy, showing the use of soot blowers on oil-fired boilers.

Representatives:—Norman L. Snow, president; Willis P. Thomas, secretary; George L. Davis, assistant sales manager; Lynn W. Nones, eastern sales manager; J. E. Heeter manager, Philadelphia office; R. L. Townsend, manager, Boston office; H. D. Folinsbee, Jr., New York marine office; C. R. Vincent, H. W. Gilson, New York representatives; Robert June, director of publicity.

WALTER S. DICKSON CO. Booths 232-3

Heating and ventilating specialties.

Representatives:—E. B. Sanders, R. B. Kleinert.

JOSEPH DIXON CRUCIBLE CO. Booth 254
Dixon products, including flake graphite, greases, paints, aluminum graphite paints, pipe joint compound and miscellaneous products.
Representatives:—J. M. Willits, Cameron MacNaughton, O. D. Shonnard, C. A. Williamson, J. W. Caldwell, Harvey Ragan, John Georg, Joseph Drayton.

DODGE MFG. CO. Booths 478-9
Power transmission equipment, including split pulleys and hangers with Timken tapered roller bearings.
Representatives:—A. P. Strong, H. P. Robbins, C. H. Upson, W. W. Dodge.

DRAKE NON-CLINKERING FURNACE BLOCK CO. Booth 227
Special types of refractory blocks for furnace linings, bridge walls and kilns. S-X air-cooled side walls and well-type furnaces.
Representatives:—W. C. Drake, president; H. Buchert, vice-president; E. B. Priebe, secretary and treasurer; T. F. Leeman, general manager; H. H. Baumgartner, service and refractory engineer; C. B. Turrell, sales engineer, and D. B. Wilson.

J. F. Glenn, H. M. Lodge, New York; H. C. Evans, A. L. Tyre, Jr., G. B. Clark, W. G. Crichton, Philadelphia.

THE EDWARD VALVE & MFG. CO. Booth 30
Edward forged steel valves, and special offset design for 600 and 900-lb. pressures.
Representatives:—W. W. Crawford, president; J. E. McDonald, sales manager; J. R. Goodwin, New York representative.

ELLIOTT CO. Booths 271-2-3
Tube cleaners, feed-water heaters and purifying apparatus, steam turbines and electric generators.
Representatives:—H. A. Pastre, C. W. Moore, W. E. Widau, Jeannette, Pa. B. G. Fernald, R. N. Gaither, H. L. Freas, C. Schmidt, A. W. Eddy, C. S. Roosa, R. N. Tilley, New York office; T. F. Crawford, Philadelphia.

LEWIS M. ELLISON Booth 44-B
New Ellison pointer draft gage, new Ellison U path calorimeter, complete line of Ellison inclined and vertical draft gages.
Representatives:—Lewis M. Ellison, Henning L. Hultman.

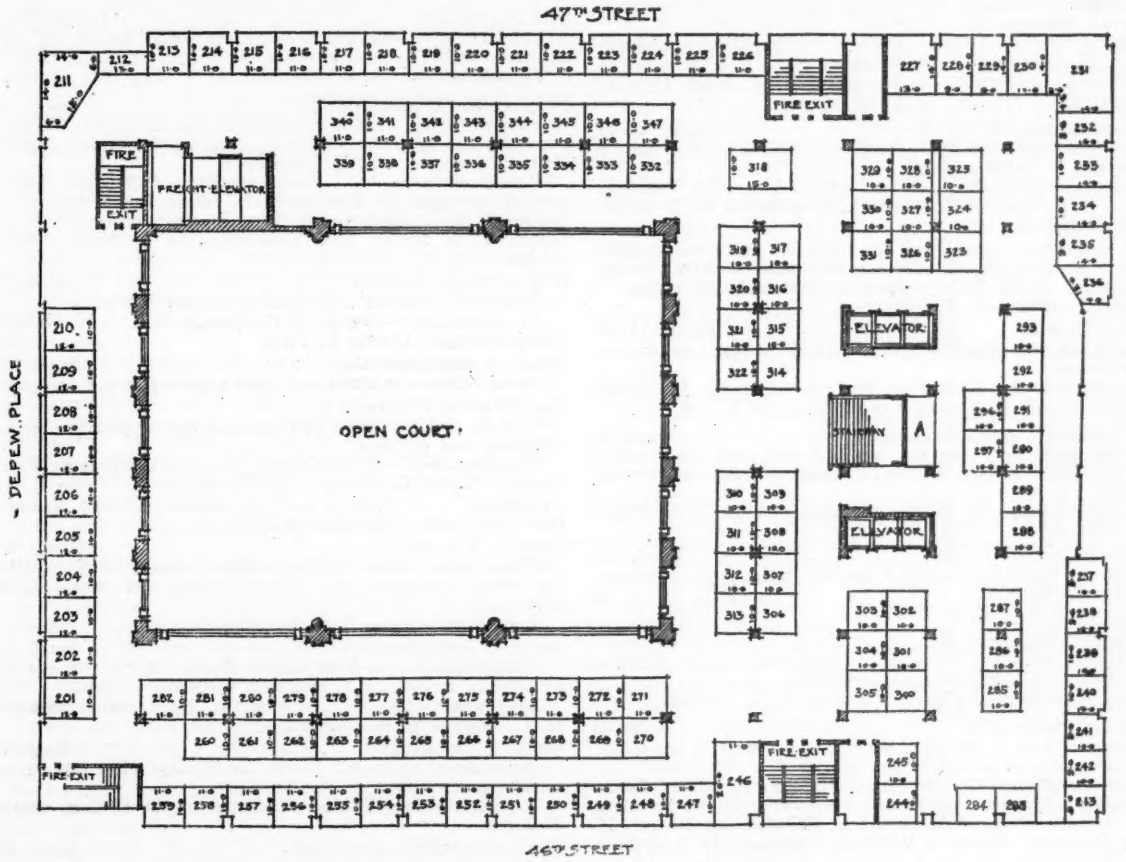


FIG. 2. THE SECOND FLOOR HAS BOOTHS 201 TO 347, ALSO A MEZZANINE

DRYING SYSTEMS INC. Booth 503
Apparatus for air conditioning, heating ventilating, air filtering.

DURABLA MANUFACTURING CO. Booths 493-4
Durable brand of packings for all services and an operating pump with glass sides to the valve chambers showing the operation of the valves.
Representatives:—E. A. Starks, G. F. Marriott, H. M. Wilson, J. G. Wholey.

EASTERN STEAM SPECIALTY CO., INC. Booth 440
Instant Water Heater, showing details of construction and method of action, and the M. J. L. Flow indicator for measuring liquids, air, steam or gas with nearby or remote installations.
Representative:—R. Palmer.

EDGE MOOR IRON CO. Booths 288-90
Edge Moor boilers, including the longitudinal drum type, waste heat type, cross-drum type, heating boilers and single pass boiler.
Representatives:—S. G. Bradford, sales manager; William Bradford, chief engineer; W. J. Williams, Kenneth Williams, Chicago; G. B. Mattingley, Pittsburgh; W. L. Ford, Boston;

CHARLES ENGLEHARD, INC. Booth 611
Measuring and recording instruments for temperatures of heaters, condensers, economizers, superheaters and flue gases, also for CO_2.
Representatives:—Henry De Gallaix, J. H. Oetjen, J. H. Allison, R. W. Newcomb.

THE ENGINEER CO. Booth 18
Enco products including balanced-draft equipment in electric and hydraulic form, oil-burning equipment, pulverized fuel burner, cross baffling for vertical water-tube boilers and Turner baffle walls.
Representatives:—K. L. Martin, Embury McLean, E. A. Holden, A. W. Patterson, Jr., Frank G. Parker, Walter Hampson, George Streisel, H. G. Brinckerhoff, H. W. Gilson, C. R. Vincent, C. R. Vincent, Jr., J. S. Merritt, J. S. Merritt, Jr., R. L. Stone, B. H. Hill, G. T. Swarts, Frank Hoyt, A. C. Danks, E. W. Nicklin, J. C. Richards, E. D. Wilkes, S. Thomas, R. K. Rothrock.

ERIE CITY IRON WORKS Booths 219-20
Unitype coal pulverizer, inclined three-drum water-tube boiler,

horizontal and vertical water-tube boilers, horizontal and vertical tubular boilers and economic self-contained tubular boiler.

Representatives:—H. H. Clemens, president; L. V. Reese, general manager; T. C. Carlson, chief engineer; W. W. Pettibone, assistant chief engineer; Chas. W. McHose, New York representative; F. G. Brinig, W. C. Heckeroth, G. D. Selden, sales engineers.

ERNST & Co. Booth 76

Inclined gage glass, gage glass valves and safety gage glasses.

EVERLASTING VALVE Co. Booths 100-1

Boiler drawoff Wylie Wilson process, Everlasting valves, tandem valve, Model X valve, companion angle valve, and Everlasting duplex blow-off.

Representatives:—John H. Allen, president; Wylie G. Wilson, engineer; E. N. Corning, sales engineer; G. L. Prentiss, New York; S. E. Carman, Geo. M. Elton, Jr.

EX-CELL-O TOOL AND MFG. Co. Booth 661

Bushings, grinding spindles and other Ex-Cell-O products.

THE FAFNIR BEARING Co. Booth 246

Full line of industrial ball bearing applications, and of radial and thrust bearings.

Representatives:—Maurice Stanley, vice-president and secretary; R. M. Hemenway, assistant secretary; C. F. Stanley, assistant manager; H. Reynolds, S. M. Cooper, H. C. King, Thos. F. Reilly, D. J. Gilbert, Geo. Barenborg.

FAIRBANKS, MORSE & Co. Booths 326-31

Ball bearing centrifugal pumps and motors, reciprocating pumps, type Y Diesel engine.

Representatives:—H. C. White, D. S. Thompson, Allan E. Ranson, A. H. Gade, J. D. Sconce, E. C. Dunstone, H. T. Miller, W. D. Hampson.

FALK CORP. Booths 338-9

Double reduction speed reducer for conveyor drive, flexible coupling for joining shafts which are considerably out of line.

Representative:—M. P. Fillingham.

FEDERAL GAGE Co. Booths 535-44

Indicating and recording gages, mercoid automatic motor control switches.

Representatives:—L. H. Van Neff, president; N. J. Allaben, vice-president; J. W. Owens, vice-president; I. E. McCabe.

THE FISHER GOVERNOR Co., INC. Booth 35

Pump governors, reducing valves, steam traps, float valves and liquid level controllers, both for direct connection and remote control.

Representatives:—L. W. Browne, vice-president; C. D. Peterson, engineer.

FLETTNER CORP. OF AMERICA Booth 630

Flettner inventions, including the Rotorship, rotor ventilator, rudder and windmill.

Representative:—F. O. Willhofft.

FLEXIBLE STEEL LACING Co. Booth 460

Alligator steel belt lacing, H. D. belt fasteners for conveyor belts, Flexco-Lok incandescent lamp guards.

Representatives:—H. Irwin Reinhorn, C. L. Garesche.

FLYNN & EMRICH Co. Booth 46

Huber stokers in operation showing the method of pre-coking coal and supply of secondary air.

Representatives:—Charles J. Huber, James F. Turner, Henry H. Hyde, Baltimore; Carl Smerling, Newark; Daniel Smerling, New Haven; Francis H. Forsythe, Philadelphia; Arthur M. Hart, Cleveland; Myron E. Whitham, Rochester; D. T. Dobyns, New York.

FOOTE BROS. GEAR & MACHINE Co. Booth 550

Worm gear and herringbone gear reduction units in single and quadruple types, high-reduction spur and worm gear unit, special gears and timing gears.

Representative:—J. R. Shayes, New York manager.

FOSTER ENGINEERING Co. Booth 84

Pressure regulators, pump governors, for high-pressure service, back-pressure valves and relief valves, float valves, automatic stop and check valves, non-return stop valves, fan engine regulators, flexible ball joints, and the Foster sight flow box.

Representatives:—Charles R. Emerson, vice-president and general sales manager; Charles A. Olson, president and general manager; James D. Rostron, sales manager, Philadelphia; George H. Bauer, manager, Chicago office; William E. Heck, assistant sales manager, Chicago; W. R. Ladewig, Los Angeles representative; Harry J. Fortier, New York representative; George E. Breece, New Jersey representative; William E. Ward, special representative.

THE FOXBORO Co., INC. Booth 62

Demonstrations of indicating, recording and controlling apparatus for temperatures, pressures, boiler and tank water levels, and CO_2 recorders; tests to demonstrate accuracy and overload capacity of distant recording thermometers; flowmeters and controllers; boiler instrument board.

Representatives:—B. B. Bristol, E. H. Bristol, B. H. Bristol, W. W. Patrick, C. S. Fuller, L. T. Tremaine, C. E. Sullivan, M. B. Hall, W. E. Booth, H. B. Moelter.

THE FREDERICK IRON & STEEL Co. Booth 501

Multi-stage and single-stage centrifugal pumps, and the Frederick revolving roll separator, for grading fuels.

Representatives:—G. R. Hargis, chief engineer pump department; Joseph T. Norman, inventor of the coal separator; Oran C. Lease, coal separator department; R. H. McCain, sales manager, pump department.

FULLER-LEHIGH Co. Booth 51

Apparatus for pulverizing of coal, for transportation and feeding of pulverized coal, pulverized coal burners, Bailey feeder and meter, vertical waste heat dryers and Bailey water-cooled furnace walls.

Representatives:—E. G. Bailey, E. J. Billings, J. B. Gaffney, Ralph Galt, H. G. Barnhurst, H. B. Jones, F. A. Scheffler, L. W. Marso, R. A. Hawk, W. O. Renkin.

THE FULTON Co. Booths 252-3

Special temperature and pressure regulating devices and the adaptation of the Sylphon principle for thermostatic water mixing.

Representatives:—A. W. Shepherd, A. W. King, F. P. Reeder.

FURNACE ENGINEERING Co., INC. Booth 41

Simplex system of unit pulverization and air separation, electric drive and magnetic separator. Illuminated pictorial demonstration of action. Hunter water floor.

Representatives:—W. C. Drake, president; A. B. Carle, assistant sales manager; H. Buchert, E. B. Priebe, I. S. Forde, H. F. Weber, E. H. Striegel, C. H. Baker, F. E. Brandis, Dr. P. A. Hirsch, T. A. McGee, New York office; D. B. Wilson, Philadelphia.

G & G ATLAS SYSTEMS Booth 87

Pneumatic tubes for mechanical messenger service.

Representatives:—Stephen J. Geoghegan, William H. Dinspel, Edmund Weigle, Charles E. Prout.

WILLIAM GANSCHOW Co. Booth 762

Speed reducers in direct and right angle types, and cut gears.

THE GARLOCK PACKING Co. Booth 505

Garlock packing service and complete line of packings for all conditions and purposes.

Representatives:—P. D. Miller, New York manager; F. P. Morton, Charles D. Castle, J. H. Reyelt, Joseph Yamin, J. M. Drinkwater, C. R. McAfee, H. O. J. Garlock, Edward W. Lane, Isaac McAllister, John McLaughlin.

GENERAL ELECTRIC Co. Booths 4-5

Flow meters, brush shifting motors, system of air cooling for turbine generators, and extensive motor and control equipment.

Representative:—C. T. McLoughlin.

GENERAL REFRACTORIES Co. Booth 530

Exhibits of fire brick in various shapes and compositions for all kinds of service and Grefco high temperature cement.

Representatives:—M. E. Pumphrey, district sales manager; M. C. Sargent, K. M. Karcher.

GILLIS & GEOGHEGAN Booth 88

Ash-removal equipment, electrically-operated under boiler room conditions.

Representatives:—William H. Staples, E. D. Hooker, Charles E. Prout.

GIRTANNER ENGINEERING CORP. Booth 258

Steam jet, vacuum and hydraulic pipe line conveyors with models of steam jet and hydraulic systems in operation.

Representatives:—Alexander Girtanner, president; J. J. McNulta, treasurer; Edwin Sauer, New York sales manager; D. A. Jenkins, district manager, New England; J. J. Joyce, field engineer; A. R. Grover, New York office; Jay G. Thomas, Philadelphia office; E. W. Weyrauch, Rochester, N. Y., office.

GITS BROS. MFG. Co. Booth 610

Oil cups and oiling devices for gravity and wick feed.

Representatives:—R. J. Gits, general manager; Frank Zeman, sales manager.

S. FABIAN GOODMAN Booth 482

Ball and roller bearings, and details of construction and parts.

JAMES T. GORDON Co. Booth 92

Water and oil strainers, speed reduction units and Nicholson steam specialties.

Representatives:—James T. Gordon.

A. P. GREEN FIRE BRICK Co. Booths 201-2

High alumina and fire clay refractories in brick, special shapes, plastic and high temperature cements, air-setting cement and fire clay mortar.

Representatives:—George E. Ford, vice-president; J. Harrison Brown, secretary; H. B. Plunkett, sales manager.

GRISCOM-RUSSELL Co. Booth 49
Evaporators, Reilly water heaters, Multiwhirl oil coolers, U-fin air coolers, steam and air separators, G-R Bentube evaporators.
Representatives:—Stanley Brown, R. L. Robinson, K. B. Millett, H. W. R. Wheeler, Robert Colston, R. W. Thompson, S. F. Maury, J. H. Thomas.

GURNEY BALL BEARING Co. Booth 343
Ball bearings and their uses for industrial machinery.
Representatives:—A. C. Davis, vice-president and general manager; L. A. Cummings, chief engineer; T. Barish, service engineer; D. K. Hatch, Springfield, Mass., M. T. Denslow, Philadelphia, Pa., sales representatives.

HAGAN CORP. Booth 21
Combustion control system for handling boilers simultaneously but individually from a central control panel. Water-conditioning outfit and a standard line of apparatus, for the purification of steam, control of boilers, and conditioning of water.
Representatives:—T. A. Peebles, chief engineer; D. J. Ericson, sales manager; Messrs. Matheny and Miller, New York office; L. Wharton-Bickley, Philadelphia manager; R. L. Sheraton, Boston manager; James S. Mess, H. T. Doran, Canadian representatives.

HARDINGE Co. Booth 337
Conical mill, reverse current air classifier, Ruggles Coles dryer and super thickener and clarifier for coal treatment and preparation.
Representative:—W. H. Withington.

THE HAYS CORP. Booth 81
Gas analysis apparatus and draft pressure gages of pointer and inclined tube type, illuminated gages for distant reading, sectioned draft and CO_2 recorder.
Representatives:—P. T. Sprague, president and general manager; Walter C. Edge, eastern manager; A. F. Bittner, New York district manager; Paul B. Huyette, general eastern representative.

HEINE BOILER Co. Booths 694-5
Blue prints of typical boiler installations, photographs of recent large plants, construction of new high pressure bent tube type boiler and samples of boiler construction and furnace equipment.
Representatives:—C. R. D. Meier, president; E. R. Fish, vice-president; W. Siegerist, engineer of sales; C. L. Kline, Philadelphia office; R. F. Burke, Phoenixville plant; John Daly, J. E. Strain, New York office; J. J. Brady, Boston office.

HENDRICK MFG. Co. Booth 431
Mitco stair treads and steel gratings, metal screens and elevator buckets.
Representatives:—B. G. Dann, A. B. Tappen, Messrs. Tull, Scott, Krulder.

PAUL F. HERMANN Booth 737
Stationary and operating models of coke oven, steam yacht, dock pump, bridge structures and other equipment.
Representatives:—Paul F. Hermann, E. A. Giessen, metallurgical engineer.

HOFFMAN SPECIALTY Co., INC. Booths 633-4
Hoffman air valves and specialties for heating systems.
Representatives:—C. V. Haynes, R. R. Emerson, H. P. Kahn.

THE M. A. HOFFT Co. Booth 502
Moving pictures of the National arch, and methods of repair, also movies of the action of the National stoker and of refuse-burning apparatus.
Representatives:—M. A. Hofft, president; William R. Van Nortwick, New York manager; Walter M. Squires.

HOMESTEAD VALVE MFG. Co. Booth 428
Quarter turn valves for water, air and steam pressures, up to 3000 lb. per sq. in. Plug type lubricated valve with Alemite lubrication. Hovalco and Homestead-Hovalco blow-off valves and Homestead protected seat hydraulic operating valves.
Representatives:—W. R. Schuchman, president; F. E. Schuchman, C. E. Powell, H. P. Ackerman, P. L. Rhodes, William Gormley.

THE HORSBURGH & SCOTT Co. Booth 455
Enclosed worm gear speed reducers in operation. Method of cutting low ratio worm and gear set.

HUTCHINSON MFG. Co. Booth 641
Woodworking machinery, including the Beaver and Speed Marvel saws, the Handy Hutch combination saw table and jointer.
Representatives:—A. B. Robinson, New York sales manager; J. G. Wells, M. E. Troeger.

THE PAUL B. HUYETTE Co. Booths 81-2
Line of P.B.H. equipment, including water gages, gage cocks and water glass adapter for changing vertical water gages to the inclined form. Reliance water column, Hays CO_2 and draft recorder apparatus, General Electric Flow meters.
Representatives:—Paul B. Huyette, president; Walter C. Edge, vice-president; Phillip Wood, secretary; Andrew F. Bittner, Henry R. Belssing, J. J. McCarthy, S. Louis Huyette.

HYATT ROLLER BEARING Co. Booths 497-8
Applications of anti-friction bearings to transmission equipment and power plant and industrial machinery.
Representatives:—F. S. Cole, H. M. Carroll, W. W. Fullager, C. L. Newby, W. F. Stone, H. A. Devine.

ILG ELECTRIC VENTILATING Co. Booth 278
Direct-connected multiblade blower with direct motor drive through flexible couplings, electric factory unit heater, and motor propeller fan, portable floor fan for cooling hot locations in industrial plants.
Representatives:—J. M. Frank, P. D. Briggs, J. O. Lennon, W. G. Thomas, C. A. Suling, A. M. Blakeney, W. Mueller.

ILLINOIS ENGINEERING Co. Booths 232-3
Glass model Eclipse steam trap operating under working conditions to illustrate the valve action. Steam and vapor specialties.
Representatives:—Walter Dickson, A. L. Brown, New York office; J. C. Matchett, J. L. Ehretsman, Chicago office.

IMPERIAL COAL CORP. Booth 771
Coals of various classes and charts showing analyses of the coals and efficiencies and evaporations obtained in tests.
Representatives:—Charles A. Owen, president, E. H. Zimmerman, sales manager; H. A. Line, Philadelphia manager; E. T. Kranefus, Boston manager; W. J. Cahill, Johnstown manager; George E. Owen, fuel engineer; A. E. Nevins, P. F. Masse, New York office; H. B. Bartley, H. C. Platt, Philadelphia office; R. E. Finnegan, Boston; H. S. Evans, Newark, N. J.

INGERSOLL-RAND Co. Booths 554-7
Cameron pumps in single and multi-stage centrifugal types. Special feature, a boiler feed pump for 1500 lb. pressure. Details of Ingersoll-Rand surface condenser.

INSTANT WATER HEATER Co. Booth 440
Heaters for instantaneous house supply.
Representatives:—Messrs. Prizer, Yoder, White, Olson, Sprenkel.

INSULATING PRODUCTS CORP. Booth 437
Pipe and fitting coverings for prevention of heat loss, photographs, samples and models of applications to power plants.
Representatives:—W. J. Greer, president; H. E. Rowaldt, Chicago; Robert Graf, Pittsburgh.

INTERNATIONAL COMBUSTION ENGINEERING CORP. Booths 23-25A
Unit system for burning pulverized fuel, Lopulco pulverized fuel system, CE furnace details, flame effect model of the Lopulco system and of the Combustion steam generator unit.
Representatives:—R. C. Beadle, Charles McDonough, G. A. Marsh, W. R. Wood.

INTERNATIONAL FILTER Co. Booths 221-2
Models of water softening by the Zeolite process, of steam purification equipment and of chemical mixing, feeding and proportioning equipment for the Lime-soda softening process.
Representatives:—P. N. Engel, president; M. P. Robinson, George E. Congdon, George H. Brown, W. J. Hughes, A. D. Hodges.

THE INTERNATIONAL NICKEL Co. Booth 9
Monel metal, pure nickel and adaptation of monel metal to the manufacture of parts of power plant equipment and apparatus.
Representatives:—L. Muller-Thym, A. E. Moss.

IRVING IRON WORKS Co. Booths 438-9
Safstep construction in standard form and the special construction with Vizabledg for added safety.
Representatives:—E. Brodhead, sales manager; C. S. Line, J. H. Miller, F. C. Yale, William Noblett, sales engineers.

D. O. JAMES MFG. Co. Booth 735
Speed reduction units, gears, pinions and flexible and universal couplings.

BENJAMIN E. JARVIS, INC. Booth 640
Jarvis Constant speed and variable speed, electrically-driven bench band saws for metal and wood.
Representative:—Leonard C. Lotz, vice-president.

JEFFREY MANUFACTURING Co. Booth 743
Coal and ash-handling and conveying equipment, including pivoted bucket type, V bucket type, belt conveyors, crushers, feeders and the like. Motion picture demonstration.
Representatives:—W. R. Roby, R. B. Renner, E. H. Raymond, L. J. Pennock, sales engineers.

JENKINS BROS. Booth 90
Full line of globe, angle, check and gate valves, of bronze and iron, also radiator valves, rapid action and self-closing valves and mechanical rubber goods. Moncrieff gage glasses.
Representatives:—F. G. Jolley, Charles Beckmann, Charles Stallings, Charles Wick, Charles Ohlsen, Thomas Kiernan.

JOHNS-MANVILLE, INC. Booths 314-15
Asbestos and its uses as applied in the making of packings, power specialties, insulations, roofings and electrical materials.
Representatives:—B. C. McClure, H. A. Kieselbach, F. J. Wakem, M. K. Cumming, M. Craighead, E. Rock.

JOHNSON SERVICE CO. Booth 403-4
Automatic control for heating and ventilating systems.
Representatives:—P. A. Riccis, Frank P. Brophy, Victor M. Lathers.

W. A. JONES FOUNDRY & MACHINE CO. Booth 464
Speed reducing and power transmission appliances, including spur gear and worm gear speed-reducing sets.
Representatives:—R. B. Moir, W. M. Sutton.

JUSTUS STEAM TRAP CO. Booth 715
Steam traps and thermostats.
Representative:—H. W. Justus.

M. KATZENSTEIN & SON Booth 625
Wiping material for cleaning off machinery.
Representatives:—James E. Katzenstein, M. Katzenstein.

THE E. F. KEATING PIPE BENDING & SUPPLY CO. Booth 228
Fabricated piping for high and low pressures, flanged joints, welded flanges and nozzles, coal work for refrigeration chemical and drying purposes.

E. KEELER CO. Booth 211
Operating models showing the circulation of the Keeler boilers and a model of the double duty type Keeler boiler.
Representatives:—E. G. Wein, general sales manager; A. C. Lippincott, New York district manager; A. C. Lippincott, Jr., assistant to New York manager; B. G. Barrows, Boston district manager; C. E. Robinson, engineer; R. E. Foresman, advertising engineer.

THE M. W. KELLOGG CO. Booth 72
Swivel and fixed type, forged, welded, tongue and groove flanged joints; forged, welded pipe nozzle; Van Stone joints, and copper-plated, welded expansion joints.
Representatives:—H. L. R. Whitney, H. B. Kendall, G. E. Kreidler, D. M. Wyman, F. Cromwell.

KEYSTONE LUBRICATING CO. Booth 3
Operating demonstration of the Keystone safety lubricating system, with accessories and methods of application, also of the Keystone grease lubricants for speed reduction units and silent chain drives.
Representatives:—H. A. Buzby, president; A. T. Lowry, New York district manager; C. O. Norstrum, special representative and lubricating engineer; C. T. Moyer, J. R. Lawrence, sales representatives; F. D. Street, sales engineering department.

KEYSTONE REFRACTORIES CO. Booth 11
Uses of Dura-Stix for covering furnace walls and application by the Keystone sprayer.
Representatives:—F. W. Reisman, president and general manager; L. E. Turk, secretary and treasurer; P. J. Murphy; J. F. McFadden; G. M. Sherman; B. G. Pitcher; J. F. Collier.

KIELEY & MUELLER, INC. Booth 456
Pressure reducing, back pressure and relief valves, stop and check valves, steam traps for 400 lb. pressure, low-pressure air eliminator.
Representatives:—J. O'Connor, secretary and treasurer; B. H. Dutcher, manager; Mr. Mayer, Mr. Schroeder.

KING REFRACTORIES CO. Booth 95
Mono boiler baffling, and Flame brand high temperature cements.
Representatives:—S. C. Smith, president; John T. Bulkley, vice-president; T. J. Bulkley, F. B. Lithgoe, T. Amory Coffin.

KISSICK-FENNO CO. Booth 19
Copes feed-water regulator, Vulcan soot cleaner, and CoKal stoker.
Representatives:—Joseph Kissick, Jr., George J. McDonough, C. R. Fischer.

KLINGERIT, INC. Booth 317
Piston valves with packing directly on the plunger, high pressure asbestos valve discs, reflex water gages, and asbestos sheet packing.
Representatives:—Thurman Strahmann, G. H. Strahmann, H. C. Strahmann.

THE KORFUND CO. Booth 627
Korfund plates for the absorption of vibration as used for isolation of machinery of all kinds.
Representatives:—H. F. Hoevel, president; S. Rosenzweig, vice-president; B. W. Dennis, Ohio representative.

LA MONT CORP. Booth 619
La Mont steam generators and duplex steam-sealed valves.
Representatives:—W. D. La Mont, W. J. Norton, A. F. Ernst, C. C. Stretch, J. B. Scheel, W. S. Anderson, Jr., G. W. Wood.

LEAD LINED IRON PIPE CO. Booth 10
Lead-lined and tin-lined iron pipe and fittings for hot and cold water, acids and chemical work; also lead-covered copper tubing.
Representatives:—John D. Dwyer, Thomas E. Dwyer, Daniel H. Regan.

THE LEAVITT MACHINE COMPANY Booth 568
Reseating machines for globe valves, gate valves and pump valves, for use in reseating without removing the valves from the line.
Representatives:—B. P. Dexter, president; R. L. Roth, vice-president; Evans G. Valens, E. S. Hersey, sales engineers.

LEEDS & NORTHRUP CO. Booths 432-4
Carbon dioxide recorder, electric flow meter, generator field temperature recorder, frequency recorder, feed-water B.t.u. recorder, station load totalizing recorder, boiler water alkalinity control, surface condenser leakage recorder and demonstration of automatic combustion control for boiler furnaces.
Representatives:—I. M. Stein, assistant sales manager; L. O. Heath, R. C. Cleeland, D. E. Moat, J. H. Hayner, E. S. Bristol, P. A. Newman.

LIBERTY ELECTRIC CORP. Booth 435
Operating exhibit of the Liberty Valve Operator, controlling a 6-in., 600-lb. Pittsburgh gate valve by local and remote push button control. Cut out control showing the functioning of all parts and the operation of the safety clutch to prevent breakage of valve stems.
Representatives:—Minton Cronkhite, president; P. W. Bliss, vice-president; C. A. Craig, sales manager; E. J. Panish, chief engineer; G. A. Mowbray, electrical engineer; Joseph McKay, Jr.

LIPTAK FIRE-BRICK ARCH CO. Booths 201-2
Self-supporting refractory side walls and suspended arch and side wall construction.
Representatives:—George E. Ford, vice-president; J. Harrison Brown, sales manager; W. H. Boyd, H. E. Sharp.

LOCKE REGULATOR CO. Booth 445
Reducing and balanced valves, the Locke damper regulator, engine stop and speed limit system, pump governor, nonreturn valves.
Representatives:—F. R. Eliason, superintendent; W. A. Heaney, assistant superintendent; Mr. Rowland, Mr. Burns, New York representatives.

LESLIE CO. Booth 678
Pressure regulators and reducing valves for steam, air and oil for both high and low pressures.

THE LINCOLN ELECTRIC CO. Booth 692
Several sizes of the Polyphase induction motors, the Linc-Weld motor running under water, the Lincoln Stable-Arc welder in operation, and various applications of arc welding.
Representative:—A. F. Davis, vice-president.

E. G. LONG CO. Booth 735
Spur gear and combination worm and spur gear speed-reducing units, silent chain drives and other types of transmission chains.
Representatives:—E. H. Mays, president; T. H. S. Andrews, W. E. Petty.

THE LUNKENHEIMER CO. Booth 63
Electrically-operated, steel, monel-mounted, nonreturn valves and gate valves with Dean and Liberty controls, and a full line of small valves in gate, globe, check and blow-off form, steel, monel-mounted, and all monel.
Representatives:—Frank P. Rhame, Oliver F. Gang, Walter A. Reynolds, William Carson.

MANISTEE IRON WORKS CO. Booths 531-2
Roturbo pumps in eight-stage horizontal form, single-stage, volute form and details of roturbo impeller.
Representatives:—D. J. Rowland, E. S. Quakenbush, A. P. Olches.

MANNING, MAXWELL & MOORE, INC. Booths 26, 60
Ashcroft steam gages, Consolidated safety valves, Metropolitan injectors and Hancock valves.
Representatives:—J. F. Schurch, president; H. D. Carlton, vice-president; W. H. Williston, assistant to vice-president; W. B. Bradbury, sales manager; W. E. Jerauld, works manager, Boston; C. H. Graesser, works manager, Bridgeport; P. G. Darling, development engineer; E. B. Crocker, mechanical engineer; P. H. Ryan, J. H. Bush, N. B. Carlton, H. Jude, W. A. Blackmore, W. J. H. Miller, sales representatives.

MARION MACHINE, FOUNDRY & SUPPLY CO. Booths 209-10
AB soot blower with valve-in-head for use on water-tube boilers, and the Gulf-stream water heater for supplying large quantities of hot water.
Representatives:—George G. Kumming, sales manager; W. H. Caldwell, New York representative.

MASON REGULATOR CO. Booths 223-4
Pump governors of pressure and speed control types, damper regulators, balanced and float valves, fan and stoker engine regulators, bronze and iron body valves for standard pressures and cast steel valves for high pressures.
Representatives:—F. A. Morrison, secretary; F. Kenneth Morrison, H. L. Colby.

MASTER WOODWORKER MFG. CO. Booth 756
Master floor sander.
Representatives:—H. M. Hirshfeld, A. Berg.

McCLAVE-BROOKS CO. Booths 401-2
Shaking and dumping grates and the M-A stokers for small sizes of anthracite shown and demonstrated in detail.
Representatives:—R. B. McClave, general manager; Stephen A. Brooks, manager; J. C. Stewart, A. J. Baldwin, New York office; George Blair, Jr., manager, Philadelphia office.

McLEOD & HENRY CO. Booth 13
McLeod and Henry flat suspended arches, Steel Mixture veneer wall blocks and the use of Steel Mixture fire brick and blocks for the building of boiler settings.
Representatives:—C. N. Morgan, president; A. L. Keeler, vice-president; F. V. Tuthill, N. S. Burnham, T. J. Fitzpatrick, New York office.

MERCO NORDSTROM VALVE CO., INC. Booth 261
Merco Nordstrom plug valves and the lubricating principle as applied to plug cocks for all kinds of power plant uses.
Representatives:—Thomas Jabine, W. L. Travers, H. P. MacGregor.

THE MERCON REGULATOR CO. Booth M
Mercon pressure regulators and chart showing the steady steam and water flow due to the use of the excess pressure regulator and water level control.
Representatives:—E. T. McCarthy, D. H. Skeen, D. S. Walker.

MERRICK SCALE MFG. CO. Booths 237-40
Conveyor scales in operation weighing out actual material, and the Merrick Mechanical Weighman in operation.
Representative:—F. P. Hambright, sales manager.

L. R. MERRITT & CO. Booth 31
Manufacturers' representative of steam specialties.
Representative:—L. R. Merritt.

MIDWEST PIPING & SUPPLY CO. Booth 268
Special pipe joints, requiring neither gaskets nor field welding for superheated steam at pressures to 900 lb. at 750 deg. Microphotographs and the results of tests on special processed Van Stone, Sargol and Midwest joint laps.
Representatives:—A. G. Stoughton, president; J. McC. Moffett, secretary; Paul F. Witte, advertising manager.

MILLRICH CO. Booth 730

MIXING EQUIPMENT CO., INC. Booth 716
Electric portable mixers for fluids.
Representatives:—F. L. Craddock; J. J. O'Shea.

MOORE STEAM TURBINE CORP. Booths 508-9
Four-inch multistage boiler feed pump driven by multistage steam turbine, oil relay governor and hydraulically-operated governor valves in operation.
Representatives:—M. D. Church, president; George R. Probst, sales manager; K. MacDonald, chief engineer; R. W. Towne, sales department; Rolland Gardner, Cleveland; Mr. Sanderson, Mr. Lix, Syracuse, N. Y.; H. A. Schultz, Pittsburgh; R. E. S. Geare, Philadelphia; J. J. Mullan, New York; H. H. Leathers, R. L. Sittinger, Boston; J. P. McRae, G. B. Greene, Ottawa, Canada; John Fensom, Richmond, Va.

MORSE CHAIN CO. Booths 262-3
Details of Rocker-Joint construction, of the Morse chain, and exhibit of silent chain of different sizes in actual operation.
Representatives:—V. D. Morse, W. W. Bertram, J. M. White, J. A. Meany, A. B. Wray, C. L. Saunders.

THE MOTO METER CO., INC. Booth 256
Motoco industrial thermometers and their uses.
Representatives:—J. C. Elverson, manager industrial division; Alfred Weiss, H. G. Boynton.

MUELLER BRASS CO. Booths 407-8
Brass and copper products in rods, tubes, forgings, castings and screw machine parts, also Relleum brass forgings, as used in commercial machinery.

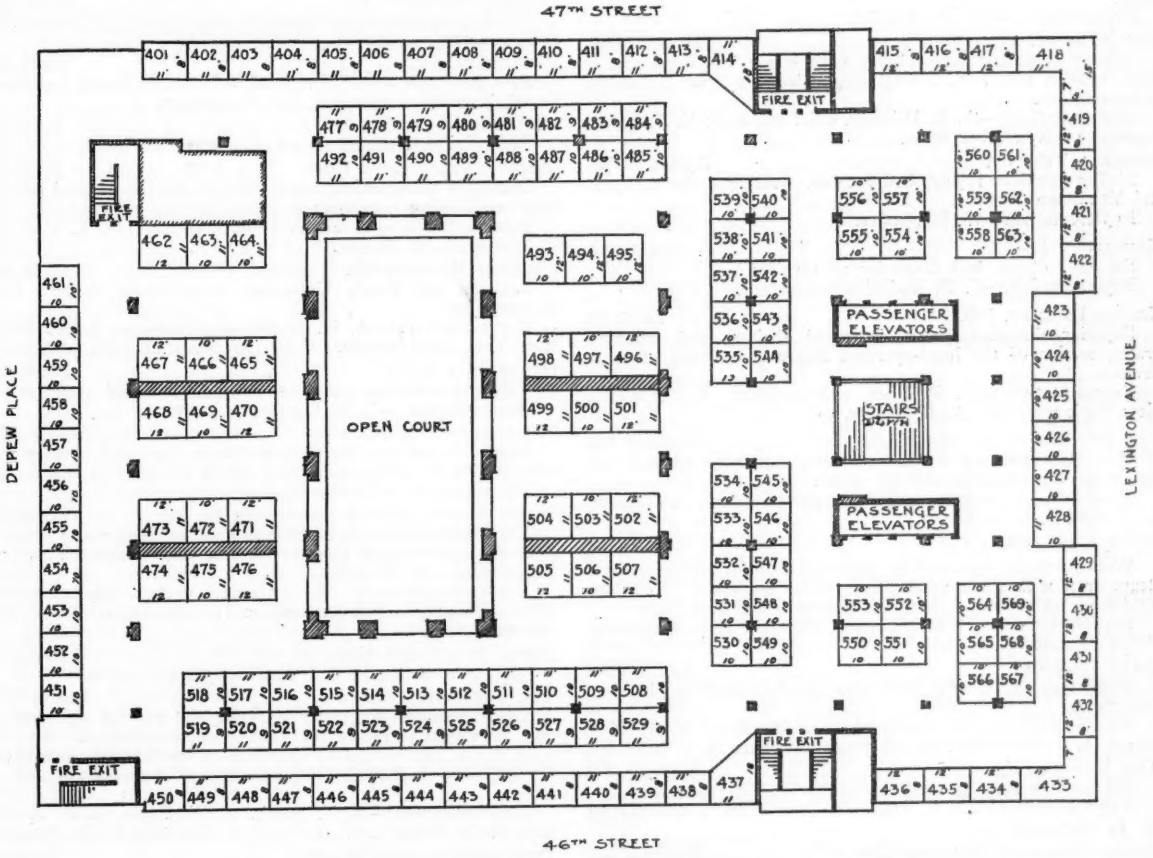


FIG. 3. NUMBERS 401 TO 569 ARE FOUND ON THE THIRD FLOOR

Representatives:—R. P. Windberg, assistant sales manager; A. P. Relken, manager, New York office.

MURRAY CONDUIT SYSTEMS Booth 300
Exhibit of conduit-forming machines for building up conduit in place and underground work, also photographs of installations of Murray conduit in power plants and substations.
Representatives:—William J. Lally, Joseph P. Mitchell, Edward Hedther, E. L. Rich.

THOS. E. MURRAY, INC. Booth 301
Details of arrangement and construction of power plants as designed by this company.
Representative:—Joseph C. Jones.

NASH ENGINEERING CO. Booth 66
Hytor vacuum and condensation pumps and sewerage ejector, circulation pumps for hot water and condenser systems.
Representatives:—R. H. Carpenter, I. V. Jennings, H. M. Wylie, Russell Donnelly, C. B. Rice.

NATIONAL CO., INC. Booth 76
Water column illuminators, for making distant reading possible.
Representative:—W. K. Sowdon.

THE NATIONAL ACME CO. Booths 561-2
Gridley automatic turret lathe, with single belt drive and a single spindle, also 1-in., five-spindle, high-speed Acme automatic screw machine.
Representatives:—A. E. Drissner, chief engineer; H. T. Latto, manager of New York office.

NATIONAL TUBE CO. Booths 8A-8B
Shelby seamless tubing, boiler tubes, welding scale-free pipe and Van Stone flanges.
Representative:—W. L. Shaffer.

NAUGATUCK MFG. CO. Booth 731
Seamless copper ball floats for all services.
Representative:—E. D. Rodenbach, secretary.

NEEMES FOUNDRY, INC. Booth 93
Superior dumping grates, improved shaking and dumping grates, section of the hand-operated stoker and details of these devices.
Representatives:—R. R. Rees, vice-president; E. C. Welsh, New York manager; A. B. Taylor.

THE NEW JERSEY ASBESTOS CO. Booth 742
"V" Pilot packing for all services, especially adapted for steam, air, oil, ammonia and hot water.
Representatives:—J. Irwin Taylor, vice-president; A. C. Rader, L. H. Gill, F. N. Anderson.

W. H. NICHOLSON & CO. Booth 92
Working model operated by compressed air of piston-operated steam trap with glass windows to show operation. Nicholson welded nickel steel float for high pressures and superheat.
Representatives:—H. S. Nicholson, manager; J. B. Armstrong, R. A. Comstock.

NILES GEAR CO. Booths 457-8
Maag type gears, in straight spur, single helical and herringbone types.
Representatives:—M. Estabrook, vice-president; A. T. Messinger, A. E. Gutzwiller, George Ramel, William A. V. Thomsen.

THE NITROSE CO. Booth 744
Nitrose for coating metal structures and its applications.
Representatives:—R. E. Hagenah, New York representative, H. R. Wetherell.

NORMA-HOFFMANN BEARINGS CORP. Booths 279-80
Complete lines of Norma precision ball bearings and Hoffman roller bearings with demonstration of anti-friction quality and a device to show the creep which takes place in bearings.
Representatives:—D. E. Batesole, F. W. Mesinger, H. J. Ritter, E. W. Lawrence, T. M. Kaino.

NORTHERN EQUIPMENT CO. Booth 19
Copes boiler feed water regulator in operation, condensate drainage control system with tank and piping, pump governor, valve movement indicator and control valves.
Representatives:—E. W. Nick, president; V. V. Veenschoten, C. E. Wolff, Jr., E. L. Bowers, N. H. Brown, J. J. Kissick, W. J. McDonough.

NORTON CO. Booths 323-5
Silicon carbide, refractories and cements, in various shapes, and also section of a boiler furnace wall illustrating the use of Crystolon brick. Section of enameling furnace and of an electric furnace showing hearth plates and supports under heat.
Representatives:—F. E. Leiby, C. W. Saxe, R. Kirkpatrick, H. B. Lindsay.

OAKITE PRODUCTS, INC. Booths 732-3
Methods of cleaning oil coolers, surface condensers and other power plant equipment with charts showing the effect of cleanliness on efficient power plant operation.
Representatives:—J. F. Tonn, sales manager; H. Liggett Gray, assistant manager; Carl Johnson, technical director; V. D. Smith, technical department; A. W. Perry, field service manager.

THE S. OBERMAYER CO. Booth 260
Refractory materials for furnace construction, high temperature furnace cement and plastic furnace lining.
Representatives:—H. E. Beckman, F. P. Bullion.

TINIUS OLSEN TESTING MACHINE CO. Booth 318
Machines for testing hardness and ductility of materials, Extensometers, strain gauges, universal testing machine, and machines for testing timing and running balance of moving parts.
Representatives:—T. Y. Olsen, vice-president and treasurer; R. B. Lewis, Jacob Lundgren, William J. Tretch.

OTIS ELEVATOR CO. Booth 57
Large steel casting valves, with control valves for superheated steam, hardening of parts and special castings of dynamo steel for rings and spiders.
Representative:—F. O. Drew.

OXWELD ACETYLENE CO. Booth 430
Welding equipment and apparatus with details of construction and operation.

PALMER-BEE CO. Booth 697
Spur gear and worm gear speed reducers, high and low speed flexible couplings, conveyors for all purposes.

PAULSON-SPENCE CO., INC. Booth 28
Steam traps, combustion control system and water softening.

PEABODY ENGINEERING CORP. Booth 47
Details of construction and installation for oil, gas and pulverized coal burning equipment and for viscosity regulators.
Representatives:—E. H. Peabody, president; H. T. Dyer, S. T. Warner, E. B. Sadtler.

PEERLESS MACHINE CO. Booth 405
Six-inch and 9-inch Universal, motor-driven shaping saws in operation.
Representatives:—A. H. Goetz, sales manager; I. M. Ward, New York representative; C. A. Schuman, assistant manager.

HENRY PELS & CO. Booth 626
Triple combination punch, shear and structural shape cutter.
Representative:—T. C. Sternblad, secretary.

PENNSYLVANIA CRUSHER CO. Booths 286-7
Bradford coal breaker, Armor frame single roll crusher and photographs of installations and details of crushing machinery.
Representative:—Stanley B. Hawthorne.

PENNSYLVANIA PUMP & COMPRESSOR CO. Booth 522
Three-inch 6-stage high pressure boiler feed pump, class 3 Pennsylvania straight line air compressor, working model of Pennsylvania air lift pump.
Representatives:—W. E. Anderson, general sales manager; W. C. Peck, advertising manager; H. Van Cleve, Philadelphia representative.

PEORIA MALLEABLE CASTINGS CO. Booth 735
Malleable castings and detachable sprocket chains.

THE PERMUTIT COMPANY Booths 3, 28
Complete model for water softening and filtering equipment as used in industrial plants for Zeolite water softeners. Also the construction and method of operation of the Ranarex instruments for recording carbon dioxide, gas density, ammonia gas and the like.
Representatives:—A. T. Smith, R. W. Epple, A. F. McConnell, F. D. West, L. E. Burke, J. S. Shedden, F. D. Harger.

PHILADELPHIA GEAR WORKS Booth 10
Worm, spur, herringbone and spiral-herringbone types of speed reducing gears.
Representatives:—H. K. Rewalt, New York office.

PITTSBURGH PIPING AND EQUIPMENT CO. Booths 401-2
Welded headers, pipe bends, live welds, special pipe joints.
Representatives:—George H. Danner, president; M. B. Schiller, treasurer; Robert Whyte, general manager of sales; D. G. Sinclair, New York; Berford Brittain, Chicago; G. Howard Boddy, Detroit; A. T. Brodie, Cleveland; George W. Smith, Indianapolis; L. K. Hamilton and Spenser Brittain, Pittsburgh.

PITTSBURGH VALVE, FOUNDRY & CONSTRUCTION CO. Booth 4
Cast steel, monel mounted and motor-operated valves, also special piping for high pressures and high temperatures.
Representatives:—J. Roy Tanner, general manager; C. A. Anderson, manager of sales; Geo. J. Stuart, chief engineer; Geo. B. Anderson, Jr., New York sales agent; Geo. S. Seltzer, Boston sales agent.

PITTS & KITTS MANUFACTURING & SUPPLY CO. Booth 451
Steam specialties including traps, reducing valves and regulators, high and low water alarms, water gages and gage cocks, high temperature cement and boiler wall covering.
Representatives:—J. R. Hughes, S. Weinik, J. V. Garneau, J. E. Arenholz, Wm. Schliemann.

PLIBRICO JOINTLESS FIREBRICK CO. Booth 93
Moving pictures of the installation of a Plibrico lining on a boiler furnace, also examples of the furnace lining and of the construction of a monolithic furnace.
Representatives:—I. S. Pieters, W. A. Shaefer, C. A. Werner, James C. Grant, William Long, William H. Patton, W. C. Herlihy, Jerry Galvin, Mr. Rabbitt.

POOLE ENGINEERING & MACHINE CO. Booth 467
The Poole all metal flexible couplings, and the Poole herringbone gear speed reducer.
Representatives:—E. W. Hardesty, general sales manager; C. M. Davison, chief engineer.

THE WM. POWELL COMPANY Booth 495
Bronze, iron and steel body valves in all types and for all working pressures and temperatures. Lubricating devices, water gages and other steam boiler room specialties.
Representatives:—James Coombs, vice-president and general manager; Wm. Heilig, Chas. Kammeron, Chas. L. Buckman, Chesley Dom.

POWER SPECIALTY CO. Booth 20
Foster superheaters of convection and radiant heat types, Foster economizers, Foster water cooled furnaces, the Aero pulverizer.
Representatives:—W. E. Dowd, Jr., R. H. Wyld, Paul Buckler, George B. Van Tuyl, John Sengstaken, F. A. Faville, Frank G. Page, J. E. Kenney, Geo. B. Ferrier, Jr., Pell W. Foster, Jr., Thos. H. Wilkins, J. K. Seabright, D. D. Pendleton.

PREFERRED UTILITIES CO., INC. Booths 304-5
Fuel oil burners including the Ray steam turbine type, 300-hp. electrically driven with steam actuated oil and air controls and Ray automatic fuel oil burner.
Representatives:—R. S. Bohn, G. W. Bohn, F. Glanz, J. S. Kaplan, D. W. Patterson, A. Roberts, J. Spalding, D. Marfield, E. B. Lipsett.

PYRAMID IRON PRODUCTS CO. Booths 306-7
Pyramid grates and details.
Representatives:—J. M. Dumphy, W. H. Cline, A. W. Foster.

QUEENS RUN REFRACTORIES CO., INC. Booth 569
Standard and special shapes of fire brick as used for heating furnaces, malleable iron practice and boiler settings.
Representatives:—C. A. Sleicher, H. S. Sleicher, J. F. Marshall, Allan A. MacLeod, C. A. Underwood, Frank Ruehe, Rosser Thomas, L. C. Andrews, D. J. Matheson.

QUIGLEY FURNACE SPECIALTIES CO. Booth 89
High temperature cement for laying up and repairing boiler furnaces, the use of Ganisand for making special shapes, Quigley refractory gun for furnace repairs and the use of triple-A protective coatings.
Representatives:—W. S. Quigley, president, J. H. McPadden, W. H. Gaylord, Jr., C. C. Gantzman, M. F. King, J. R. Mack, D. F. McMahon, F. J. Spillane, T. Hind, H. M. Thompson, H. M. Miller.

RACINE TOOL & MACHINE CO. Booth 499
Shear cut saw for high speed metal cutting, also motor driven metal cutting machines in operation and Duplex band saw machines for cutting metals.
Representatives:—M. E. Erskine, president; S. P. Schafer, eastern factory representative.

RAMSEY CHAIN CO., INC. Booths 292-3
Silent chain drive with roller bearings, and compensating joints.
Representatives:—J. H. Ramsey, vice-president; D. I. Wheeler, S. E. Anderson.

READING STEEL CASTING CO. Booth 48
Cast steel valves in various sizes and types and in gate, globe, angle and check form, some equipped with Dean control, others with ball bearing hand wheel.
Representatives:—R. T. Hatch, J. P. Ferguson, W. D. Cashin, W. McCausland, W. E. Foster, C. W. Stephen, E. C. Magens, A. W. Taggart, H. H. Freund, Jr.

REED AIR FILTER CO. Booth 466
Complete self-cleaning air filter in operation. Representative:—J. R. McConnell, sales manager.

REEVES PULLEY CO. Booth 26
Variable speed transmission over wide continuous range.
Representatives:—R. S. Reeves, secretary, C. L. Irwin.

THE RELIANCE ELECTRIC & ENGINEERING CO. Booths 620-1
Alternating and direct-current electric motors with sleeve and anti-friction bearings, also watertight direct-current motors with special insulations, for severe conditions.
Representatives:—J. W. Corey, assistant sales manager; P. T. Gross, New York sales manager; R. H. Smith, Boston sales manager; A. B. Coffman Philadelphia sales manager; W. G. Gude, New York office.

THE RELIANCE GAUGE COLUMN CO. Booth 82
Reliance safety water columns, for pressures from 250 to 650 lbs. and gage cocks for pressures up to 1,500 lbs.
Representative:—J. Rowland Brown.

REPUBLIC FLOW METERS CO. Booth 6
Republic indicating and recording devices, including steam flow and water meters, air and gas meters, liquid level recorders, draft instruments, duplex and single record pyrometers, boiler meters and gas producer control instruments.
Representatives:—J. D. Cunningham, president; Geo. S. Hendrickson, manager and E. C. Horton, R. L. Morse, New York office; C. E. Pritchett, manager, Pittsburgh office; J. A. Morehouse, manager, Boston office; J. W. Hogg, manager and S. A. Anderson, Philadelphia office.

RICHARDSON SCALE CO. Booths 283-4
Model coal weighing apparatus in actual operation showing the use of the automatic scale and the hand operated weigh larry.
Representatives:—H. E. Godfrey, secretary and treasurer; C. R. Clark.

RILEY STOKER CORP. Booths 78-9
Riley Atrita unit pulverizer in operation, with latest developments, flare type pulverized coal burner with three sources of air supply, two-retort Riley stoker and specially designed poppet valve to eliminate steam leakage.
Representatives:—F. H. Daniels, president; D. K. Beach, treasurer; Wm. Pestell, vice-president; J. W. Armour, engineering manager; J. W. McElroy, superintenednt; I. A. Taylor, chief engineer; R. J. Krieger, manager, sales service department; Messrs. Griffith, Mather, Jordan, Schultz, New York office.

THE ROBERTS STEAM SPECIALTY CO. Booth 548
Water columns of various types, floats of copper and steel, water gage adapter and gage illuminator, also weighted lever gage cocks and other specialties.
Representatives:—G. W. Osborn, president and treasurer; Geo. F. Sommer, secretary.

JOHN R. ROBINSON Booth 243
Steelbestos gaskets for watertube boilers, triple blade tube-hole cleaners, safety boiler latch, gauge glasses.
Representative:—M. S. Hartye.

ROLLWAY BEARING CO., INC. Booth 514
Radial and thrust bearings of precision type, rollway line shaft bearings, adapter pillow blocks, etc.
Representatives:—J. T. R. Bell, general manager, C. A. Call, sales manager; J. D. Firmin, Philadelphia, district manager; Samuel Farrell, Youngstown district manager.

THE ROTO CO. Booths 11-A
Boiler tube cleaners, hand hole seat scrapers, cup cleaning machines and reseating machines.
Representatives:—W. M. Kelley, J. V. Doherty.

RUGGLES-KLINGEMANN MFG. CO. Booths 558-60
Special controller panel for boiler feed operation and regulating devices for pressure, temperature, pump action and furnace pressure.
Representatives:—Walter G. Ruggles, president; Charles B. Klingemann, treasurer; James L. Kimball, mechanical engineer; F. N. Currier, C. K. Wallance, New York representatives; A. L. Tobin.

RUTHS ACCUMULATOR CO., INC. Booth 490
Photographs and details of the Ruths steam accumulator system for storing and re-storing heat energy in the form of steam.
Representatives:—Roger A. Miller, general manager; M. B. Carroll, sales manager; F. A. Wettstein, chief engineer; C. W. Miller, H. C. Dunbar, R. I. Todd, J. P. Wys, sales engineers.

SARCO CO., INC. Booth 33
Thermostatic steam traps, temperature regulators, strainers, heating specialties and packless inlet valves.
Representatives:—E. J. Ritchie, R. W. Cumming, R. C. Doerr, J. L. Bruns.

SAUERMAN BROS. Booths 520-1
Working model of an actual coal storage yard showing the use of power drag scraper equipment for storing and reclaiming coal.
Representatives:—D. D. Guilfoil, G. R. Moore, H. M. Cooper.

THE "S-C" REGULATOR MANUFACTURING CO. Booth 213
Feed-Water regulators, pump governors, S-C Master control and differential regulating valves, all for standard and for high pressures.
Representatives:—J. M. Barrett, secretary and general manager; H. S. Fraser; W. G. Stephan; Y. C. Smith.

SCHADE VALVE MFG. CO. Booth 500

SCHUTTE & KOERTING CO. Booths 334-5
Boiler feed injectors, reducing valves and Klinger piston valves, multi-jet condenser, generator air cooler, gear rotary pump, radial fin tubes, steam purifiers for use inside the boiler.

Representatives:—H. W. Philbrook, C. T. Keet, New York office; G. Heinemann, Philadelphia office.

SCOVILL MANUFACTURING CO. Booth 69

Cup-drawn admiralty condenser tubes, brass mill products, including sheet, wire, rods and tubing, partly manufactured goods, including special shaped rods, blanks, and forgings.

Representatives:—Philip Davidson, Charles A. Gleason, George B. Kerr, Jr., L. L. Williams.

SCULLY-JONES & CO. Booth 752

Reserviced machinery and power plant apparatus.

SEMINOLE CHEMICAL CO., INC. Booths 217-18

Boiler cleaning system.

Representatives:—Leo Sherman, Thomas L. McKenna, R. F. Carbon, H. W. Hall.

S. M. SHACKELFORD Booth 730

THE SHARPLES SPECIALTY CO. Booth 92

Super centrifuge machines for purification of fuel oils, dehydration of transformer oils, purification of lubricating oil and a sectioned machine to show the operating principles.

Representatives:—H. H. La Ment, vice-president in charge of sales; B. B. Davidson, manager, William Wicht, N. Leighton, New York office; E. M. Noble, manager Boston branch; L. H. Clark, chief chemist; A. U. Ayres, chief engineer; L. D. Jones, research engineer.

SHERWOOD MFG. CO. Booth 244

Hart forced speed lubricating system and appliances.

Representatives:—William B. Putney, president and treasurer; Irvin H. Kaufman, vice president.

JOHN SIMMONS CO. Booth 519

Packing, pipe fittings and accessories, installations of power plant piping, bends, headers, coils.

Representative:—R. E. Thomas.

SIMPLEX VALVE & METER CO. Booth 76

Feed water measuring devices, including the simple indicating type, indicating and recording type, and the meter for indicating, recording and totalizing.

Representatives:—W. K. Sowden, New York office.

S K F INDUSTRIES, INC. Booths 332-3

Ball bearings for all purposes and applications to shafting bearings of all types.

Representatives:—D. W. McAllen, R. H. DeMott, H. H. Yeager, A. Veith, J. D. Williamson, C. A. Decker, R. C. Byler.

SKIDMORE CORP. Booth 700

Vacuum pumps for condensing and heating systems.

Representatives:—B. Skidmore, Jr., S. H. Sprague.

M. B. SKINNER CO. Booth 563

Pipe clamps, service clamps, flange clamps, and reseating tools in operation.

Representatives:—M. B. Skinner, president; K. G. Merrill, vice-president and manager; F. A. McMurray, sales manager.

F. L. SMIDTH & CO., INC. Booths 281-2

Models illustrating the action of the Lenix short center belt drive, in comparison with open drives, and the instant automatic response to peaks and valleys in loads.

Representatives:—A. B. Zahn, assistant treasurer; Viggo Sahmel, electrical engineer and manager of Lenix and electrical departments; Robert Salmonsen, mechanical engineer and assistant manager of the Lenix department; B. Oberg, T. Offrel, O. Andreasen, J. Grant, B. F. Clark.

SMITH & SERRELL Booth 85

Flexible couplings for motor turbine and engine drives with demonstration of the methods for handling misalinement, shock, vibration and endwise displacement.

Representative:—John J. Serrell.

SMOOT ENGINEERING CORP. Booths 417-19

Combustion control system in operation, under various loads showing the control of fuel and air to maintain uniform steam pressure and CO_2. Also Smoot feed regulator as applied to pulverized fuel feeders and stokers.

Representatives:—C. H. Smoot, R. A. Wright, C. L. Joly, C. J. King, S. B. Decamp, H. R. Kessler, J. F. Shadgen, E. W. Trowbridge, S. R. Higgs, E. Allen, A. J. Sicree, J. K. Mawha, H. K. Blanning, D. L. Fagnan, F. H. Plum.

SNAP-ON WRENCH CO. Booth 449

Line of Snap-on socket wrenches and handles for square and hexagon nuts from 3/16 to 1½-in. and for use in confined locations.

Representatives:—Stanton Palmer, N. E. Tarble, Joseph Johnson, William A. Seidemann, R. D. Holmes, C. H. Tennyson, sales engineer.

SOWDEN & GREENE Booths 76, 500

Simplex Valve & Meter Co. Products, Ernst & Co. water gage glasses, National Separator and Machine Co. products.

Representative:—W. K. Sowden.

SPRINGFIELD BOILER CO. Booths 31-2

Working model of water tube boiler and details of construction.

Representatives:—George W. Stetson, L. R. Merritt, R. B. Klienert, O. N. Carter, W. H. Jacobi, Robert Lacy.

STANDARD STEEL & BEARINGS, INC. Booth 336

SRB single and double row annular ball bearings and MRC thrust bearings, also illustration of the methods of manufactuer.

Representatives:—L. A. Cummings, chief engineer; W. H. Hill, sales manager; H. A. Johnston, assistant sales manager; W. F. Jones, engineer; R. L. Dabney, New York representative.

STANDARD TURBINE CORP. Booth 461

Unit type turbines for direct drive of pumps, exciters and blowers, also in larger sizes for direct connection to AC and DC generators; special nozzle control.

Representatives:—A. R. Calvo, George D. Brougham.

STERLING ENGINE CO. Booths 446-7

Commercial type gasoline engines with counterweighted crank shaft for high speed driving of pumps, generators and other power equipment.

Representatives:—Maurice E. Mutthler, general sales manager; Charles A. Criqui, Jr., advertising manager.

STERLING ENGINEERING & MFG. CO. Booth 28

Operating lifting trap, details of parts and method of operation.

Representatives:—Charles G. Stebbins, E. Sherman Hall, Herbert W. Brandt.

STEWART-SAYERS CO. Booth 26

Oil purification systems for engine and transformer oils.

STROM BEARING CO. Booth 534

Single and double row radial bearings, angular contact and thrust bearings with details of construction.

Representatives:—M. E. Monk, sales manager; H. N. Parsons, chief engineer, A. W. Wiese, manager, Philadelphia office; J. K. Stahl, manager, Springfield, Mass., office; Cora C. Smith, manager, advertising and sales promotion.

THE STRONG-SCOTT MFG. CO. Booth W-76

Working models of the Unipulvo pulverizer, and of the coal dryer, also the Unipulvo burner and photographs of methods of burning pulverized coal.

Representatives:—A. W. Strong, president; H. G. Lykken, combustion engineer and inventor; H. L. Rank, sales manager, W. K. Sowden, F. W. Greene, C. J. Hunter, F. T. Breed, representatives.

B. F. STURTEVANT CO. Booths 411-414

Steam turbines, forced draft fans and undergrate blowers, economizers with lead-coated tubes, special type air economizer.

Representatives:—R. E. Shaw, sales manager; G. C. Derry, manager, fuel economizer and mechanical draft; H. A. Morton, turbine manager; J. F. Daggett, manager New York office; H. Clay Moore, southern agent; H. F. Colby, A. C. Townsend, E. H. Gaither, W. A. Finnegan, G. B. Page, sales engineers New York office; H. F. Daley, Camden; P. C. Ekblom, western division; W. G. Tellin, Pittsburg.

THE SPENCER TURBINE CO. Booths 452-3

Spencer turbo compressors for supplying air from 1 to 3 lb. pressure.

Representatives:—F. A. Wright, manager; E. J. Skillman, Frank Martin, New York office.

SUMET CORP. Booth 769

Demonstration of properties of Sumet metal as bearing material.

Representative:—H. O. Warner, New York office.

THE SUPERHEATER CO. Booth 56

Superheater units taken from the Hell Gate New York Station, and the Fordson Plant at Detroit, after several years of service, to illustrate results of operation at high temperatures and under severe operating conditions.

Representatives:—R. M. Gates, manager, industrial division; Leon H. A. Weaver, publicity manager; B. R. Bristol, B. N. Broido, D. S. Carter, A. H. Charles Dalley, F. A. Schaff, V. W. Smith, R. L. Ehmann.

THE SWARTWOUT CO. Booths 229-30

Swartwout ventilators for boiler room ventilation, Swartwout separators and other products including low-pressure float and high-pressure bucket traps.

Representatives:—D. K. Swartwout, Sr., D. K. Swartwout, Jr., H. C. Miller, Geo. H. Thomson, Percy Jones, J. W. Johnson, L. P. Russon.

SWEET & DOYLE FOUNDRY & MACHINE CO. Booth 477

Gas fired heat treating furnace, power gas burners and air gas proportioning control valves with a working model. Condensation eliminators and utility strainers.

Representatives:—Theodore Haight, engineer equipment division; R. S. Latimer, chief engineer; Harry H. Dodge, gas department; S. H. Payne, Metropolitan sales department.

SWIFT MACHINERY CO. Booths 766-7
Motor-driven, screw-cutting lathe with special attachments.
Representatives:—Clarence M. Swift, Emil Bangs, George C. MacConnell, E. S. McGonegal.

C. J. TAGLIABUE MFG. CO. Booth 59
1927 model TAG mono duplex recorder, indicating CO and CO_2 in flue gases, with large illuminated dial; both records are made on one 24-hour circular chart. Recording and dial indicating thermometers, industrial thermometers, recording pressure and vacuum gages, automatic controllers for temperature, pressure and humidity, oil testing instruments.
Representatives:—L. C. Irwin, vice-president and general manager; H. D. Cooke, general sales manager; V. Wichum, chief engineer; R. M. Wilhelm, technical advisor; C. O. Fairchild, engineer in charge of pyrometric research department; W. C. Begeebing, division sales manager; M. F. Behar, advertising manager, August Rucks, L. M. Hackenberg, sales engineers.

W. O. & M. W. TALCOTT, INC. Booth 734
Talcott belt fasteners for all kinds of belts, tests showing comparative strength of various fasteners in rubber and leather belting.
Representatives: W. O. Talcott, president and treasurer; M. W. Talcott, vice-president and secretary.

TAYLOR INSTRUMENT COS. Booth 507
Thermometers of indicating and recording type for flat chart and barrel, with single or double records; combined recording thermometer and pressure gage, indicating and recording pyrometers, aneroid and murcurial barometers, temperature controls for self operation and air operated, long distance transmitting thermometer, direct reading superheat indicator.
Representatives:—C. B. Carson, sales manager recording thermometer department; J. W. Schwarz, sales manager, industrial thermometer department; F. E. Ely, manager, New York office; F. M. Herrick, advertising manager; J. P. Gilmore, H. W. Kugler, W. N. Maurer, New York office.

TECHNO-SERVICE CORP. Booths 265-6
Cut out model of Borsig 8-in. valve for 400 lb. pressure at 750 deg. temperature, operated by Cutler-Hammer motor control unit. Samples of Borsig special steel for high temperature welding.
Representatives:—F. K. Loeffler, E. Doderer, Charles Cless, Jr., Joseph K. Wood, W. H. Baker, D. H. Bierman.

THE TERRY STEAM TURBINE CO. Booths 207-8-9
Demonstration of single and multi-stage steam turbines, also of the uses and construction of reduction gears and flexible shaft couplings.
Representatives:—R. L. Thomsen, sales manager; B. H. Wood, publicity manager; J. D. Stout, New York manager; V. L. Sanderson, Philadelphia manager.

THE TEXAS CO. Booths 748-59
Method of preparing and refining of lubricants, and samples of power plant lubricants.
Representatives:—H. W. Dodge, G. R. Rowland, G. W. Vos, C. R. McCarthy, W. L. Kallman, F. W. Smith, L. O'Malley, H. MacRobert, Jr.

THOMAS FLEXIBLE COUPLING CO. Booth 406
Flexible shaft couplings.

TIDE WATER OIL SALES CORP. Booths 15-A
Samples of the complete line of lubricants manufactured by the corporation, including oils and greases for all power plant conditions.
Representatives:—A. R. Nelson, metropolitan industrial sales supervisor; J. L. Bailey, industrial oil manager; W. B. Joachim, eastern department, industrial sales supervisor; P. F. Cassidy, Edward Milligan, lubricating engineers.

THE TIMKEN ROLLER BEARING CO. Booth A
Timken tapered roller bearings and applications to electric motors, line shafting and other industrial machinery.
Representatives:—T. V. Buckwalter, vice-president; L. M. Klinediust, general manager, and W. B. Moore, assistant general manager of the industrial division; E. Wooler, chief engineer; S. M. Weckstein, industrial equipment engineer; R. P. Kelley, advertising manager; district managers of the industrial division, S. C. Merrill, A. J. Norris, H. H. Gildner, L. D. Warrender, J. L. Young, J. B. Baker, B. E. Keifer.

TOPPING BROS. Booths 512-13, 524-8
Cored bar products, push drills, welding equipment and Simplex jacks.

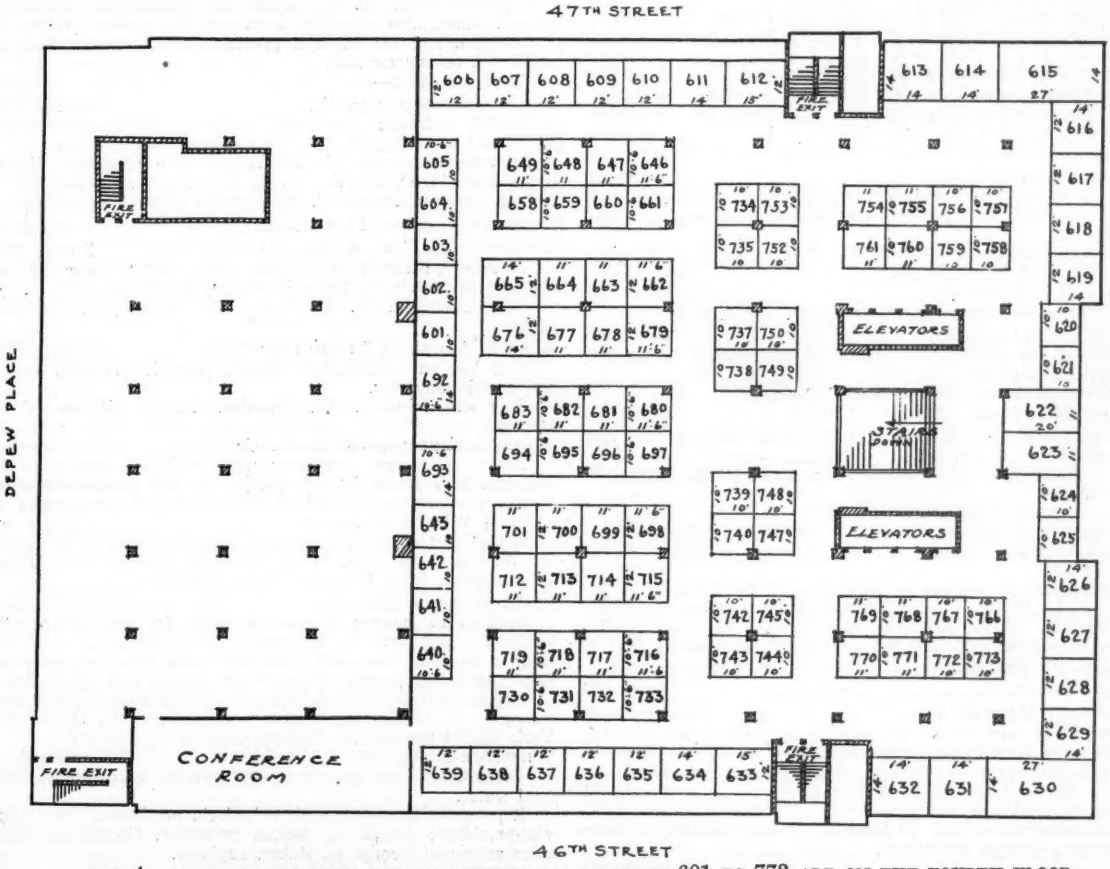


FIG. 4. CONFERENCE ROOM, MOTION PICTURES AND BOOTHS 601 TO 773 ARE ON THE FOURTH FLOOR

TORCHWELD EQUIPMENT CO. Booths 527-8
Oxy-acetylene welding and metal cutting apparatus, torches, gas regulators and supplies.
Representatives:—W. A. Slack, president; Roy J. Petty, E. W. Gardner.

TRILL INDICATOR CO. Booth 745
Outside spring indicators, continuous card indicators, check valves, flushometers, planimeters and indicator cocks.
Representative:—W. L. Trill.

THE TRI-LOK CO. Booths 675-6
Safety treads for stairways and fire escapes, concrete armoring and reinforcing for platforms, floors, stairs, roads and sidewalks, gratings and grills for registers, windows and radiators, sidewalk doors and gratings and other simialr material for power plant and factory construction.
Representatives:—H. Nagin, secretary and general manager; W. H. Van Orden, assistant general manager; W. McKee, sales manager; C. A. Roberts, assistant sales manager.

TRIPLEX MACHINE TOOL CO. Booths 646-7, 661
Grinding spindles and jig bushings, measuring instruments, jig boring machines, and scientific apparatus including lathes, milling machines and dial gages.
Representatives:—John Cetrule, Nicholas Cetrule, P. E. Seibel, J. H. Wilhelm, R. Y. Ferner, William F. Wise, Charles Ameel, L. E. Larson.

20TH CENTURY WOODWORKER OF NEW YORK, INC. Booth 740
20th Century woodworker for all kinds of woodworking operations, and the Decora paint spray equipment for air brush painting.
Representatives:—C. L. Leake, in charge; L. C. Laub.

UEHLING INSTRUMENT CO. Booth 45
Waste meter for flue gases and combined barometer and vacuum recorder, CO_2 recorders, pyrometers, automatic control systems.
Representatives:—F. Uehling, C. C. Phelps, C. J. Schmid, P. C. Riccobene, F. D. Bogia.

UNION CHAIN & MFG. CO. Booth 735
Sprockets, buckets, conveyor, chain and elevators.

THE UNISHEAR CO. Booth 476
Unishear for cutting sheet metal in complicated forms and also steel plates up to ¼ in. thick.
Representatives:—Ulrich Senidors, president.

VASTINE SALES CORP. Booth 750
Furnace fire observer for continuous observation of fire and brick work in the furnace.
Representatives:—R. P. Vastine, secretary; Joseph Lappin, E. Toussaint.

VINCENT-GILSON ENGINEERING CO., INC. Booth 17
Diamond soot blowers, Tracyfiers, Smith gas producers, Warren steam pumps, Carling turbine blowers, products of the Engineer Co.
Representatives:—Grant B. Bradshaw, L. F. Kuhman, P. H. Miner, A. L. Menzin, G. M. Kirkpatrick of Andrews-Bradshaw Co.; Earl E. Adams of Smith Gas Engineering Co.; A. W. Carlson of Carling Turbine Blower Co.; C. R. Vincent, H. W. Gilson, C. R. Vincent, Jr., of Vincent-Gilson Engineering Co.

ALFRED VISCHER, JR. Booth 683

HENRY VOGT MACHINE CO. Booths 269-70
Drop-forge steel valves and fittings for high steam pressure and for extra high hydraulic pressure.
Representatives:—Walter F. Hannon, Jr., Paul F. Witte.

VULCAN ELECTRIC BRAZER & WELDER CO. Booth 634
Electric band saw brazer.
Representatives:—Carl Hakemeyer, vice-president; Charles Hakemeyer, George Holterhoff.

THE VULCANITE RADIATOR CO. Booth 714
Extended surface heaters, radiators and heating cabinets, also the extended surface tubes for various structures.
Representative:—Y. Bergstrom.

THE VULCAN SOOT CLEANER CO. Booth 19
Self-contained Vulcan operating head, ratchet operating head and special corrosion-resisting blower elements.
Representatives:—F. W. Linaker, vice-president and general manager; Wm. C. Ihde, sales manager.

WAILES-DOVE-HERMISTON CORP. Booths 296-7
Tile lined coal and ash bunkers, Bitumastic and Hermastic paints and enamels for prevention of corrosion.
Representatives:—Hugh M. Cook, assistant general manager; Paul G. L. Hilken, W. S. Adams.

WAITE DAVEY & CO., INC. Booth 58
Suspended arches, air cooled side wall blocks, and rear combustion arches.
Representatives:—Frank H. Waite, president; D. W. Davey, K. H. Woolson.

WALLS SALES CORP. Booth 640
Simplex and duplex abrasive band grinders, both electric and belt driven, for metal or wood. Jarvis electrically driven constant speed and variable speed band saws.
Representatives:—Edward Grossman, president; Walter Miller, Leonard C. Lotz.

THE WALSH & WEIDNER BOILER CO. Booths 250-1
Details of water tube boilers, including forged steel sectional headers.
Representative:—W. E. Weigel.

WALWORTH CO. Booths 44A, 308-11
Sigma steel gate valves and fittings, also a general line of brass and iron body valves. Tests of Kewanee unions demonstrated.
Representatives:—W. C. Mattox, F. H. Morehead, J. J. Harman, F. W. Duemler, G. H. Galbraith, W. H. Weber, F. M. Churchill.

WARREN STEAM PUMP CO. Booth 231
Exhibit of centrifugal and reciprocating pumps.
Representatives:—Wm. W. Shuttleworth, treasurer and general manager; H. J. Hathaway, sales manager; J. G. Rearick, chief engineer; H. T. Waldo, sales department; John B. Nibling, Philadelphia district manager; P. A. Collins, Boston sales department.

WARREN WEBSTER & CO. Booths 225-6
Latest developments in vacuum and modulation systems of steam heating, also improved apparatus for quick handling of condensation and air through process systems using steam up to 100 lbs. per square inch.
Representatives:—

THE WATSON-STILLMAN CO. Booths 772-3
Special hydraulic equipment, including valves, compressors, pumps and other apparatus.
Stillman, president; C. W. Wigtel, vice president; W. B. Uppdegraff, H. D. Nitchie, W. A. Kelly, E. L. Breaden, W. J. Waters, sales engineers; E. B. Fleming, advertising manager.

WEHNCKE RESILIENT MOTOR BASE CO. Booth 683

WESTINGHOUSE ELEC. & MFG. CO. Booths 487-9
Turbine generators in various sizes, direct connected and geared types. Micarta gears in various forms and sizes.
Representatives:—C. G. Ong, C. C. Wylam, P. H. Grunnagle.

WESTON ELECTRICAL INSTRUMENT CORP. Booths 510-11
Full line of switchboard meters, portable precision meters, and speed indicators.
Representatives:—J. W. Dowden, L. C. Nichols, C. B. Denton.

WHEELER CONDENSER & ENGRG. CO. Booth 64
Model of surface condenser with reversing water flow for cleaning, also steam jet air pumps, hotwell pumps, expansion joints, cross-sectioned model of evaporator and photographs and slides of Wheeler equipment.
Representatives:—H. S. Brown, E. R. Goodrich, E. L. Cahoon, H. Wetjen, J. H. Bell, D. K. Dean, C. Russell, J. A. Potter, R. D. Spear, F. J. Swenson, H. L. Robinson.

C. H. WHEELER MFG. CO. Booth 77
Radojet air pumps in various types for use with surface condensers and with the barometric intercondensers. Also twin drain control for removing condensate from inter and after condenser and photographs of condensers, pumps and installations.
Representatives:—C. H. Wheeler, vice-president and general manager; G. L. Kothny, executive engineer; B. K. Mould, New York district manager; J. Dobson, engineer.

WHEELOCK-BOGUE, INC. Booth 682
Ferro-Chem and apparatus for scientific treatment of boiler feed water.
Representatives:—Louis N. Wheelock, president; John Calder, vice-president; Joseph C. Bogue, treasurer; George H. Berge, sales manager; George O. Baker, engineer.

THE WHITNEY MFG. CO. Booth 249
Whitney silent chain in double bearing pin and bushing type, rolling joint type, standard steel roller type.
Representatives:—C. E. Wertman, sales manager; D. I. Wheeler, sales engineer; R. A. Glass, sales representative; R. J. Howison, district manager, Philadelphia.

THE D. E. WHITON MACHINE CO. Booth 471
Lee steam turbine for boiler feed and other uses, demonstrating the action of the follow-up governor, the constant speed governor, the emergency overspeed stop and the no water stop.
Representatives:—L. E. Whiton, H. B. Lee, W. E. Beaney.

THE WICKES BOILER CO. Booth 285
Lantern slide demonstration of the various types of boilers, views of installations, photographs and blueprints of construction details.
Representatives:—E. B. Wickes, H. E. Aldrich, J. W. Hulihan, R. J. Stormont, E. A. Dunton.

WILSON WELDER & METALS CO. Booths 485-6
Type S welding machine in portable form and a complete line of Color-tipt welding wire and accessories.
Representatives:—E. D. Bransome, vice-president; Alexander Churchward, consulting engineer; S. S. Stewart, production man-

ager; E. E. Tisza, engineering department; E. C. Madison, J. A. Quarmby, sales engineers; Stanley Marks, demonstrator.

L. J. WING MFG. CO. Booth 61
Wing blowers in turbine and motor driven types, featherweight unit heater for low ceiling installations, scruplex exhauster and scruplex fan.
Representatives:—A. E. Seelig, president; H. S. Wheller, vice-president; V. H. Carples, secretary and treasurer; C. F. Smith, advertising manager; C. L. Meyer, C. H. Smith, J. H. Carbone, sales engineers.

WISCONSIN ELECTRIC CO. Booths 766-7
High speed precision grinders, drills and fractional horsepower motors.
Representatives:—E. S. McGonegal, New York manager; Geo. Cary, C. J. Seibel.

T. B. WOODS SONS CO. Booth 529
Power transmission appliances, including belt contractors, flexible couplings, and ball bearing hanger boxes.
Representatives:—C. O. Wood, W. H. Fisher, T. B. Wood, G. H. Wood, C. E. Bailey, G. R. Washinger.

WORTHINGTON PUMP & MACHINERY CO. Booths 555-7
Diesel engines, centrifugal and reciprocating pumps, feather-valve air compressors, water and oil meters.
Representatives:—C. W. Rice, H. L. Conklin, E. W. Hammond, K. F. Bernard, J. H. Messerly, C. K. Hood, R. H. Lloyd, F. W. Hankins.

WRIGHT-AUSTIN CO. Booth 236
Crescent weighted try-cock, glass-replacing union for water gages, chain-pull water gages and try-cocks. A new surprise device is announced by the company.
Representatives:—C. Burt Walter, president, Henry Dusenbery, New York manager.

THE YALE & TOWNE MFG. CO. Booths 622-3
Ball bearing electric chain hoist, differential chain blocks, ball bearing chain blocks, screw geared chain blocks, hand traveling crane ends, of pressed steel and trolleys for crane construction.
Representatives:—H. J. Fuller, manager, material-handling equipment sales; R. P. Anderson, C. O. Hedner, M. G. Peck, J. R. Ransdell, R. E. Wilson, W. F. Randall, C. B. Veit.

YARNALL-WARING CO. Booths 7A-7B
Yarway blow-off valves for pressures up to 900 lbs., V-Notch recording liquid meter with hook gage for checking accuracy. Yarway involute spray nozzles and special type nozzles for aeration of water.
Representatives:—L. G. Case, New York district manager; D. T. Newman, Charles H. Thompson.

"X" LABORATORIES Booth 259
Use of "X" boiler liquid for repairing steam and hot water boilers.
Representatives:—Edward R. Tolfree, president; Carlton B. Stetson, advertising manager; L. D. Patterson, office manager; John W. Gannon, eastern representative; John M. Harder.

Consumers' Coal Stocks Increase Despite Exports

CONSUMERS' STOCKS of bituminous coal have increased in spite of the extraordinary exports stimulated by the great strike of the British miners, according to a survey as of Oct. 1, completed Nov. 8 by the Bureau of Mines, Department of Commerce.

Bituminous coal is rarely stored at the mines, the Bureau explains. The important element in the stocks is the quantity held by consumers. On October 1, commercial consumers and retail dealers had on hand a total of 44,000,000 t. of bituminous coal. This was 5,000,000 t. more than the stock on July 1, indicating that production in August and September was sufficient to supply domestic consumption and provide a surplus for storage, in addition to the large amounts exported.

The total stocks compared favorably with those on similar dates of the last two years. On Sept. 1, 1924, the stocks were 47,000,000 t., on Sept. 1, 1925 they were 43,000,000 t. and on Nov. 1, 1925 about 48,000,000 t.

At the rate of consumption in August and September, the stocks on Oct. 1 were sufficient to last 35 days, if evenly divided. The condition in individual communities and establishments, however, varies widely. Some consumers protect themselves with heavy reserves and others carry little or none.

Developments since Oct. 1, according to the Bureau, indicate that further additions have been made to stocks. Production of bituminous coal in October has been extremely heavy, averaging 12,315,000 t. a week.

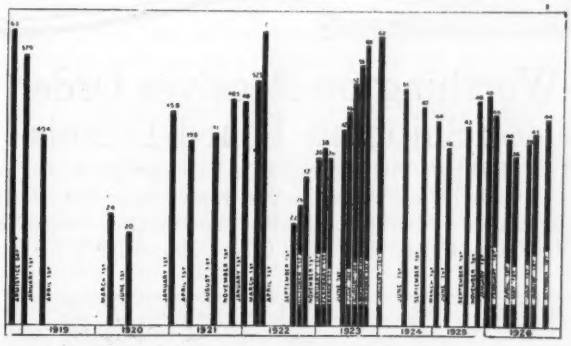


FIG. 1. TOTAL COMMERCIAL STOCKS OF BITUMINOUS COAL NOV. 11, 1918 TO OCT. 1, 1926

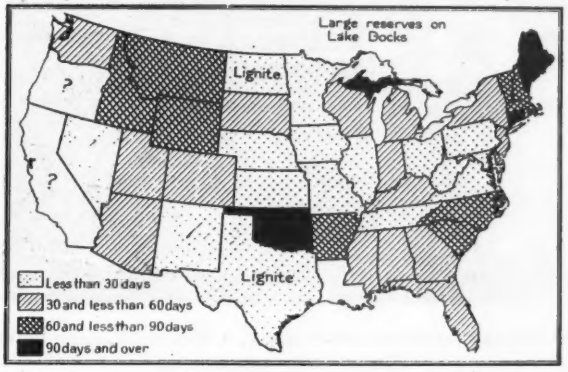


FIG. 2. DAY'S SUPPLY OF SOFT COAL ON HAND AT INDUSTRIAL PLANTS OCT. 1, 1926, EXCLUDING STEEL AND BY-PRODUCT COKE WORKS

According to the Bureau's statement of Nov. 8, production for the week ending Oct. 30 is estimated at 13,430,000 net tons. This is the highest weekly output ever recorded and is a gain of 5.6 per cent over the estimate for the preceding week. The total production for October is 54,566,000 net tons.

Cumulative production of soft coal during 1926 up to Oct. 30 amounts to 460,842,000 net tons. Figures for corresponding periods in the past 6 yr. show that the 1926 record equals that of 1920 but is exceeded by that of 1923. This is in correction of a misstatement in a preceding report.

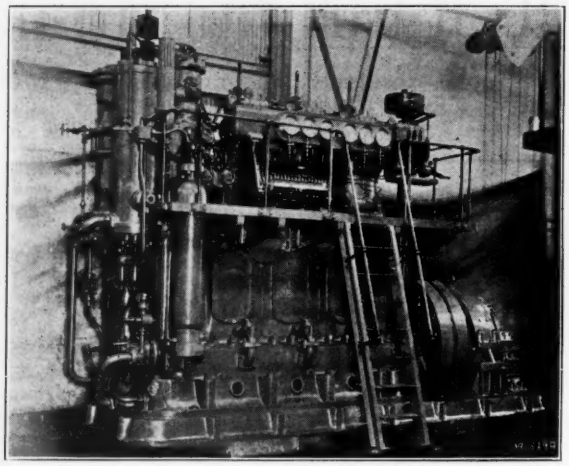
Consumption and exports in August and September averaged 10,273,000 t. a week, of which 936,000 t. was exports and 9,337,000 t. internal consumption. In spite of the abnormal demand, the actual exports absorbed only 9 per cent of the supply.

Total production of anthracite during the week ending Oct. 30 is estimated at 1,805,000 net tons, a decrease of 12 per cent from the estimate for the preceding week.

POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS

Worthington Receives Order for Shipping Board Diesels

IN THE U. S. SHIPPING BOARD'S program of conversion of idle ships, the first repeat order for Diesel engines has been placed with Worthington Pump & Machinery Corp., New York City. This order is for six



AUXILIARY DIESEL ENGINES FOR U. S. SHIPPING BOARD DRIVE 65-KW., D.C. GENERATORS

auxiliary Diesel engines for installation on the motorships Sewakla and City of Rayville. These engines are duplicates of those being installed on the Tampa and Unicoi. On the latter ships the main propelling engines are of the Worthington double-acting, 2-cycle type.

For the Sewakla and Rayville the auxiliary Diesel engines, one of which is shown in the accompanying illustration, are of the three-cylinder type, delivering 115 hp. at 265 r.p.m. They drive 65-kw., d.c. generators, which supply power for lighting as well as for operating various equipment in the engine rooms and on deck.

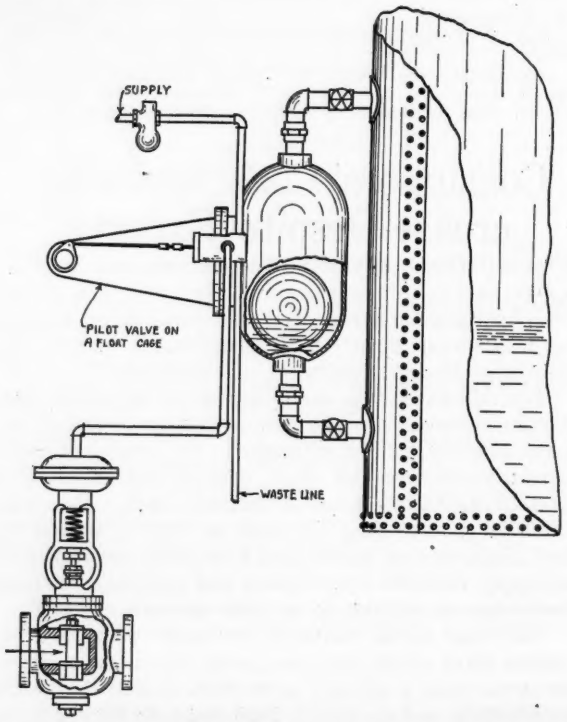
The engines are of the vertical, 2-cycle, port-scavenging, air-injection type and are built with crossheads. Stuffing boxes are fitted between the working cylinders and the crank case to prevent contamination of the lubricating oil by oil from the working cylinders. These stuffing boxes also permit the use of the underside of the motive pistons and the lower part of the motive cylinders for furnishing the requisite scavenging air. Laidlaw Feather valves are used for the valve service in the scavenging cylinders.

The crank case is entirely enclosed and all parts of the running gear are lubricated by a forced-feed system. A single pump delivers lubricating oil to the running gear and cooling oil to the motive pistons. This pump takes its suction from the crankpit and returns oil to the running gear and pistons through a large cooler, the whole arrangement designed to maintain an exceptionally low temperature in all parts of the engine.

Each engine is supplied with an air compressor large enough to furnish injection air for its own requirements and also 170 cu. ft. of free air per min. for charging maneuvering tanks and, in case of emergency, for supplying injection air to the main propelling engines. The design of this compressor is such that, when the excess air is not required, the extra cylinder for supplying this air is cut out by a simple device.

Fisher Remote Control of Liquid Levels

FOR THIS service the liquid level controller is fitted with a transmission device so that the valve may be operated at a considerable distance from the float cage. This liquid transmission unit consists of the sylphon bellows attached to the float gage, which, by means of



FISHER REMOTE LIQUID LEVEL CONTROLLER PERMITS LOCATING CONTROL VALVE AT A DISTANCE FROM THE TANK

a connecting rod and rod crank, is expanded or contracted as the float rises and lowers.

Connected to this bellows is a flexible copper tube, the other end of which is connected to a second bellows, having its free or moving end connected to the valve stem of the controller valve. Bellows and tubing are completely filled with a liquid and hermetically sealed to prevent its escape.

In operation, with the float cage placed upon the side of the tank or receiver, the change of liquid level in the tank causes the float to rise or fall, either expanding or contracting the bellows attached to the float cage. This movement either forces the liquid from the bellows or, due to its expansion, draws liquid from the valve bellows and into the float cage bellows, so that movement of the float causes the valve to open or close as the float rises and falls, due to the liquid transmission system, which really uses the force of the float to operate the valve many feet away from the float cage.

No lost motion is present as all parts of the system are rigidly in contact with each other. This means that a slight movement of the float immediately causes a movement of the valve.

While this valve is used largely in the oil industry in the production, refining and gasoline plant equipment, a common installation is on accumulator tanks, the valve being placed many feet away from the tank. Flexibility of the apparatus permits changing position of bellows on the float cage so that the valve may be made to open as the float rises, or, if the operator desires, to close as the float rises.

Often, the controller is used with a pump, which is either pumping into or taking its discharge from a receiver. In such an installation, the valve is placed in the steam line, carrying steam to the pump. Change of liquid level in the tank causes the unit to throttle flow of steam according to the level of liquid in the tank.

This liquid level controller is the product of the Fisher Governor Co., Marshalltown, Ia.

Detroit Edison to Build Delray No. 3

DURING THE LAST few years the system load of the Detroit Edison Co. has been increasing very rapidly. Since 1913, when the system output for one day reached 1,000,000 kw-hr., this figure has been growing larger until a new record was established on Thursday, Sept. 23, 1926, when the output passed the 7,000,000 kw-hr. mark.

This growth has, of course, necessitated the enlargement of various plants of the Detroit Edison Co. and especially Trenton Channel plant, in which No. 4 unit, a 50,000-kw. machine, was turned over on Oct. 18. The other new machine for service at Trenton Channel, No. 5 unit, is being assembled and will probably be ready for operation before the first of the coming year, according to the Detroit Edison Synchroscope.

At the same time that these machines were ordered, two 50,000-kw. machines were also ordered for delivery to Delray in 1928, but it has since been decided to build an entirely new power house at Delray to house the new turbines and their boilers. Difficulties in installing additional capacity at Delray due to load conditions and construction problems in rebuilding the power house led to the decision to build this plant and on Sept. 13 orders were issued for its design and construction, the first units to be in operation in 1928.

The new plant, to be known as Delray Power House No. 3, will be located between the present plant and the river. It will be square with the harbor line, which will turn the building at an angle with the center lines of the existing power houses. The completed plant will have room for eight turbines and, for purposes of study, it has been assumed that there will be 20 boilers.

Units have not been definitely selected but there is a possibility that the turbines will be similar to the last machines installed at Trenton Channel, that is, 50,000-kw., single-cylinder units operating at 400-lb. pressure, although consideration is also being given to a turbine cycle using 550-lb. pressure with cross-compounded machines. No decision has as yet been reached as to whether the boilers will be fired with stokers or pulverized coal. The boilers proper will probably be the same size as the 3000-hp. units used at Trenton Channel but the coal-burning capacity of each boiler will be more than that of the Trenton Channel boilers.

Work has already been started on the dock which will lie along the river side of the plant. The screen house for the new plant will be located on the present intake canal and construction will be started here in the near future. Work is also under way for the coal-handling equipment for the new plant.

Electric Gas Analysis Equipment

IN THE equipment made by Charles Engelhard, Inc., of 30 Church street, New York City, for the analysis of flue gases, the Wheatstone Bridge method of measurement is utilized. Spirals P_1 and P_2 are completely encased in quartz, to give mechanical protection and to prevent the gases from coming in direct contact with the platinum wire. These spirals are heated electrically by the battery B, the spiral P_2 being sealed in an atmosphere of pure dry nitrogen. Over spiral P_1, a small volume of gas is drawn continuously. As long as both spirals are surrounded by gas with the same thermal conductivity, resistance of the two is equal, and the bridge remains in balance with the pointer of the galvanometer G at zero.

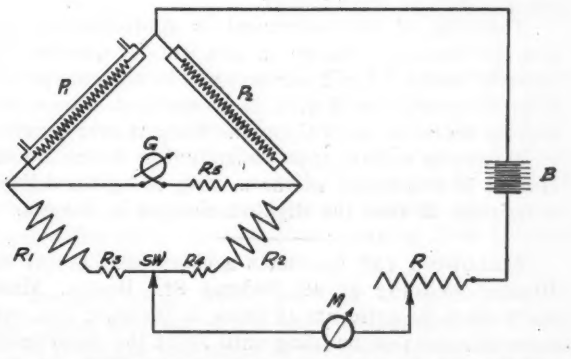


FIG. 1. WHEATSTONE BRIDGE PRINCIPLE OF THE ELECTRIC FLUE GAS ANALYZER

When flue gas is passed over the spiral P_1, the resistance of the platinum wire immediately increases because the wire gets warmer from inability of the carbon dioxide in the flue gas to conduct the heat from the spiral as rapidly as does the nitrogen surrounding spiral P_2. This unbalances the bridge of the galvanometer, and the instrument pointer is deflected in proportion to the amount of carbon dioxide in the gas. Readings of the galvanometer can therefore be calibrated to indicate the percentage of CO_2 in the flue gas being analyzed.

Commercial arrangement of the apparatus is indicated in Fig. 2, which includes a calcium chloride dryer, a porous refractory thimble, gas analysis unit, a jar for indicating the rate of gas flow, a jar for collecting moisture from the intake line, a porous intake filter. Besides this the outfit includes the recorder shown in Fig. 3, and a current control box including rheostat and milliammeter. There is, of course, an aspirator for drawing gas through the analyzer.

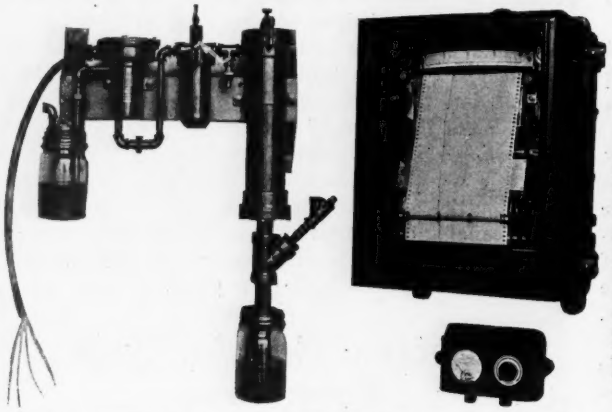


FIG. 2. ASSEMBLY OF APPARATUS OF THE ENGELHARD GAS ANALYSIS EQUIPMENT

FIG. 3. TYPE S RECORDER AND CURRENT CONTROL BOX

Time lag of the instrument is approximately 1½ min. so that any change in gas can be detected accurately within 0.3 of 1 per cent within a 30-sec. period. Type S recorder in Fig. 3, is arranged to give a continuous record of the CO_2 in the flue gas over a period of 30 days on a chart approximately 6 in. wide. Double method of suspension of the moving coil gives delicate indications of even the slightest changes in the gas.

FOLLOWING THE PURCHASE a short time ago of the 10-story building at 49 Federal St., Boston, Mass., the various departments of Stone & Webster, Inc., will move into the new building until all of the departments of this concern are located under one roof.

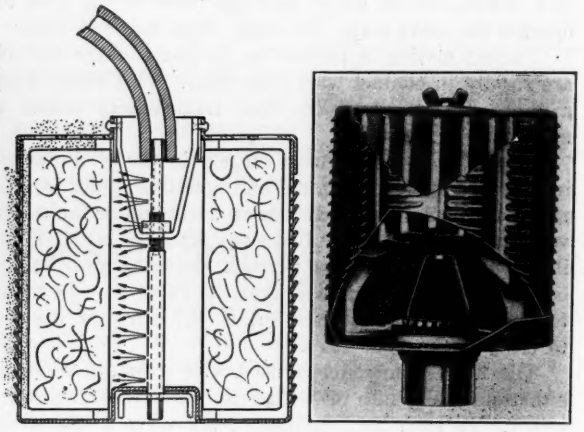
The investment banking department will be the first to occupy quarters in the Stone & Webster Building and this will be followed by the other departments now at 147 Milk St. The organization will occupy 65 per cent of the structure.

This is the fourth time since its organization that Stone & Webster has outgrown its quarters. Since its inception in 1889 the company has grown steadily and continually until today it has in operation power plants generating more than 2,750,000 hp. The company has projects in all parts of the world involving capital of $800,000,000.

Air Filter Cleaning Device Now Available

BY MEANS of the newly-developed tubular retaining bolt construction, Protectomotor air filters made by the Staynew Filter Corp., Rochester, N. Y., may be quickly and efficiently cleaned. Protectomotors have a wide application in practically all industries especially to air compressor and Diesel engine installations.

Under ordinary dust conditions cleaning is not necessary but when continually exposed to severe dust it is advisable to blow the dust off the dry felt filter insert occasionally. The ease with which this may be done with an ordinary air hose is shown in the illustration. Since the speed of the air flow through the felt is relatively slow, the dust collects on the outer surface of the felt in a light coating which is easily blown off by the cleaning air blast blowing backwards through the felt at about ten times the usual velocity. As the bolt is turned slowly one complete revolution, air is blown into each pocket of the insert in turn and the dust collected on the felt is blown from the surface.



AIR JETS CLEAN POCKET OF THE FILTER AS THE THRU-BOLT IS TURNED THROUGH A COMPLETE REVOLUTION

This improvement is not only applicable to new protectomotors but can be attached to the models already in use by substituting the solid retaining bolt with the new tubular type.

Cement Gun, a Correction

REFERENCE made in the article on page 1182 of the November 1 issue to the "Cement Gun" in connection with a machine other than that manufactured by the Cement Gun Co., Inc., was in error, as the article should have referred to the Refractory Gun. The Cement Gun Co., Inc., controls patents on the machine which it manufactures under the trade-marked name, "Cement Gun," which name it also owns. The patents cover hydration in transit which is essential to placing of dry materials in making masonry or furnace repairs.

To FROWN, 64 muscles must come into activity. To smile requires the action of but 13 muscles. Why work so hard?

Death of James B. Stanwood

JAMES B. STANWOOD, vice-president and consulting engineer of The Stanwood Corp., Cincinnati, Ohio, and inventor of numerous improvements on steam engines and boilers, died at his home in that city on Oct. 22, 1926.

Mr. Stanwood was born in West Cambridge (now Arlington), Mass., in 1855, and graduated from the Massachusetts Institute of Technology in 1875. Mechanical engineer for the Lane & Bodley Co., Cincinnati, until 1886, he later was employed by the Arctic Ice Machine Co., Cleveland. Returning to Cincinnati in 1888, he was one of the organizers of The Houston, Stanwood & Gamble Co., serving it as vice-president and consulting engineer until 1924 and serving its successor, The Stanwood Corp., in the same capacity.

Mr. Stanwood was a member of the American Society of Mechanical Engineers for 37 yr. He was also a member of the American Society of Heating & Ventilating Engineers and the Engineers' Club of Cincinnati, and was the author of a number of technical books.

News Notes

PRESIDENT W. L. ABBOTT, of the American Society of Mechanical Engineers, announces the following appointments: Honorary vice presidents to represent the society at the National Conference of the American Academy of Political and Social Science, Charles Penrose, H. Birchard Taylor and R. H. Fernald. Professor E. C. Schmidt has been appointed honorary vice president to represent the A.S.M.E. at the International Conference on bituminous coal, while H. G. Brownell has received a similar appointment covering the Annual Convention of the American Vocational Association.

ACCORDING TO A RECENT ANNOUNCEMENT, the high pressure plant at the Lakeside station of the Milwaukee Elec. Ry. & Light Co., Milwaukee, Wis., is now in regular operation. The boiler supplies steam at 1350 lb. pressure to a 7000-kw. turbine running at 3600 r.p.m. and exhausting at a pressure of 320 lb. per sq. in. During a recent test of this boiler it was subjected to a hydrostatic test pressure of 2100 lb. per sq. in.

HUGH L. COOPER, head of Hugh L. Cooper & Co., New York, consulting engineers, has had plans approved by the Ukrainian Government for a proposed hydroelectric project on the Dnieper River which, when completed, will have an output in excess of 600,000 hp., together with an extensive transmission system.

THE CHAIN BELT CO., Milwaukee, has taken over the Stearns Conveyor Co., Cleveland, Ohio. This makes the sixth of a group of affiliated companies, which now consists of the Chain Belt Co., Sivyer Steel Casting Co., Federal Malleable Co., Interstate Drop Forge, all of Milwaukee; Nugent Steel Castings Co., Chicago, and The Stearns Conveyor Co., of Cleveland.

Acquisition of the Stearns company was by purchase of all capital stock. The company will continue to operate as a separate corporation, with Earl D. Stearns as president, the manufacturing plant located in one of the newer industrial sections of Cleveland. Some of the branch offices at New York, Pittsburgh, Chicago and Salt Lake will be consolidated with the present Chain Belt offices in the same cities.

The Chain Belt Co. will continue the manufacture of power transmission chain, elevating and conveying machinery, and concrete mixers in its two plants, one in Milwaukee and the other in West Milwaukee, where a new engineering building is now under construction.

LINK-BELT CO., Chicago, Ill., announces that its Boston office has been moved to Room 1103-4 Statler Bldg., Boston, Mass.

SINCE NOV. 1, 1926, the Salt Lake City office of the Hardinge Co. has been located in the Continental Bank Bldg., 200 South Main street, Salt Lake City, with W. L. Penick in charge.

BETSON-JEWELL, INC., successors to Betson Plastic Fire Brick Co., Inc., Rome, N. Y., announces that H. L. Herron is its new representative at the machinery exhibition department, Bourse Bldg., Philadelphia, and B. A. McGinley at 25 Church street, New York City.

LIBERTY MFG. CO. announces that its general offices, formerly located at Pittsburgh, have been moved to the Elliott Company General Office Building at Jeannette, Pa., and that J. P. Rodgers continues as sales manager for the Liberty business.

AN IMPORTANT HONOR has recently been conferred on Gen. Charles Keller, of the Byllesby Engineering & Management Corp., Chicago, by his appointment as a representative of the United States Government to attend the 14th International Congress of Navigation to be held at Cairo, Egypt, in December, 1926.

IN THE PROCESS OF MAKING a preliminary survey for the building of a high-tension transmission line between Cleveland, Ohio, and the proposed site of a new power plant to be built at Dillies Bottom, Ohio, opposite Moundsville, by the Ohio Public Service Co., the route to be followed by the line has been photographed from the air.

ANNOUNCEMENT HAS RECENTLY been made that the Timken Roller Bearing Co., Canton, O., has obtained an order for bearings for 127 railroad cars for the Chicago, Milwaukee & St. Paul Railroad. These cars will all be used on the two crack trains of the railroad: one the Pioneer Limited, running between Chicago and Minneapolis; the other the Olympian, running from Chicago to Tacoma and Seattle.

JENKINS BROS., New York City, in commenting on the recent proposal of a 5-day working week by Henry Ford to be put into effect by the Ford Motor Co., gives the plan its hearty endorsement but states that it is not a new idea, as it has been in operation in the valve manufacturing plant of Jenkins Bros. in Bridgeport, Conn., for over 4 yr. Announcement of the plan was made on May 21, 1922, and on October 14, 1926, Vice President Barrington, of Jenkins Bros., made the following statement: "I can now say after four years of experience that the 5-day week has been an absolute success. Our absentee record is wonderfully improved and the records show that even our production per hour is improved. We have never heard a complaint and I am sure the employes would protest vigorously if we changed back to the old schedule."

DEVELOPMENT of a line of electric motor-operated regulators covering control of pressures and temperatures is announced by Ruggles-Klingemann Mfg. Co. of Salem, Mass. These cover operation of dial switches or drum controllers for variable-speed pumps and blowers; steam, wind box or over-fire pressure control of uptake or forced-draft dampers; operation of throttling valves to regulate speed of steam-driven pumps or blowers or for reducing pressure. Motor-drive is becoming increasingly popular for both auxiliaries and regulating devices, hence the development of this line of motor-operated regulators.

THE WALSH & WEIDNER BOILER CO., Chattanooga, Tenn., announces that Harold A. Brangs, for 3 yr. sales engineer in that company, has resigned to take charge, in association with Clarence Emil Doll, of the sale of the Vorticose Dust Collector manufactured by Dust Recovery, Inc., New York City.

BRIDGEPORT BRASS CO., Bridgeport, Conn., announces that C. W. Sproull, of Allen, Sproull & Allen, Fort Worth, Tex., has arranged to represent the company in the Southwest. It also announces that J. R. Brandt has joined the Cleveland office as raw material salesman in the Pittsburgh territory and parts of Ohio.

LINK-BELT CO., Chicago, Ill., announces that it has extended the horsepower range of Link-Belt silent chain drives available from the present scale of ½ to 10 hp. up to 15 hp. in practically any reduction up to 7 to 1.

Catalog Notes

A REARRANGED and revised circular has just been published by the Westinghouse Electric and Manufacturing Co. that gives the reader a more clear conception of supervisory control and its equipment. It deals first with a general discussion of supervisory control and then takes up Synchronous Visual Type of equipment, the Code Visual Type, and the Audible Type in the order mentioned, finishing with a discussion of the supervisory control protective equipment.

FULTON DIESEL ENGINES are described by Fulton Iron Works Co., St. Louis, Mo., in a new 28-page, attractively-illustrated bulletin. Description and illustration are given of the advantages of the 4-cycle principle and air injection, details of the lubricating system and the various parts of the engine.

NORTHWEST ENGINEERING Co., Chicago, Ill., in an attractive 12-page bulletin, discusses and illustrates many typical uses of Northwest cranes. These are employed in all types of construction work, such as sewers, transmission lines, coal handling and so on.

C. J. TAGLIABUE MFG. CO., Brooklyn, N. Y., has just issued a comprehensive and revised edition of the Tagliabue "Codex," a catalog of its industrial thermometers. Tag-Hespe glass is described and illustrated, as well as details of the various types of thermometers; tables are given showing dimensions, pipe sizes and prices of the various styles.

ORTON CRANE & SHOVEL CO., Chicago, Ill., in its new bulletin No. 42, completely describes and illustrates the Orton model "V" half-yard gasoline shovel. This unit has flexible crawling treads, revolves in a complete circle, is equipped with a 53-hp. gasoline motor, power clutches in the operating mechanism, direct-connected shaft and gear drive crowding device, independent clutches for all operations and a fully enclosed steel cab. Data are given on results obtained with the shovel applied to many different types of motors and interesting photographs show the shovel both in its details and in its methods of application.

KEYSTONE REFRACTORIES CO., New York City, has issued a 4-page folder describing the Keystone sprayer designed to "shoot" plastic refractory materials containing Dura-Stix and Steel Veneer onto boiler furnace walls.

CORNELL IRON WORKS, INC., Long Island City, N. Y., has just issued a 32-page illustrated bulletin describing various types of steel rolling shutters and doors designed for application to all types of buildings. These can be furnished for motor operation, for automatic fire doors and similar applications.

ANDREWS-BRADSHAW CO., Pittsburgh, Pa., in a new 4-page folder discusses standard specifications for clean and dry steam. Savings effected by using steam of these standard specifications are noted and a discussion is given of the way in which it can be produced by preventing entrainment.

THE SHERMAN CORP., engineers, Boston, Mass., has issued in pamphlet form a reprint of an article by John F. Sherman, its president, on problems of the average business and the remedy, which should prove of general interest to industrial plant engineers. This is the first of a series of such articles.

WRIGHT MFG. CO., Lisbon, O., in catalog No. 11, presents a 72-page, well-illustrated book describing all types of Wright chain hoists, trolleys and hand cranes. Discussion is given on choosing a hoist, followed by complete data on all types of Wright hoists with tables of capacities, dimensions and price lists.

E. KEELER CO., Williamsport, Pa., in its new 48-page catalog, describes and illustrates the two types of water-tube boilers which it manufactures, as well as the horizontal return tubular boilers and the Keeler double-duty boiler. The final pages of the book illustrate shop methods and equipment. The illustrations show cross-sections of typical installations, as well as details of the boiler parts.

IN A RECENT 8-page bulletin, No. 1026, W. H. Nicholson & Co., Wilkes-Barre, Pa., describes the Nicholson flexible coupling. This consists of two cast steel hubs keyed to their respective shafts; in the hubs, dove-tail slots are cut to receive floating steel keys, the whole enclosed in a cast iron casing bolted together with a gasket. The clearance between the floating keys and the slots in the hub permits correction of misalinement in the two shafts.

MIDWEST AIR FILTERS, Inc., Bradford, Pa., in a recent 4-page folder, describes the Midwest self-cleaned air filter. In this filter, the filter cells form a screen moving on sprocket wheels similar to the design of traveling water screens and are driven through gear reducers and silent chains from a small motor mounted on the side of the unit. The standard Midwest filter medium is used in demountable and interchangeable filter cells and no free oil or oil spray is used. Air flows through both sides and top of the filter and a sediment drawer is provided at the bottom for cleaning.